NATIONAL URANIUM RESOURCE EVALUATION

AERIAL RADIOMETRIC AND MAGNETIC SURVEY

NATIONAL TOPOGRAPHIC MAP

SONORA

TEXAS

FINAL REPORT

MAY 1980

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PREPARED FOR U.S. DEPARTMENT OF ENERGY
Assistant Secretary for Resource Applications
Grand Junction Office, Colorado

UNDER CONTRACT NO. DE-AC13-76 GJO 1664

AND BENDIX FIELD ENGINEERING CORPORATION SUBCONTRACT NO. 80-418-S

This report is a result of work performed by Geodata International, Inc., through a Bendix Field Engineering Corporation Subcontract, as part of the National Uranium Resource Evaluation. NURE is a program of the U.S. Department of Energy's Grand Junction, Colorado, Office to acquire and compile geologic and other information with which to assess the magnitude and distribution of uranium resources and to determine areas favorable for the occurrence of uranium in the United States.

AERIAL RADIOMETRIC AND MAGNETIC SURVEY

SONORA NATIONAL TOPOGRAPHIC MAP

TEXAS

WEST TEXAS PROJECT

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE
GRAND JUNCTION, COLORADO

UNDER BENDIX FIELD ENGINEERING SUBCONTRACT NO. 80-418-S
BY
GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

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ABSTRACT

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Sonora National Topographic Map NH14-4 is presented in this report. The airborne data gathered is reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included, with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included also.

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SECTION I

INTRODUCTION

SECTION I.

INTRODUCTION

A. SURVEY AREA

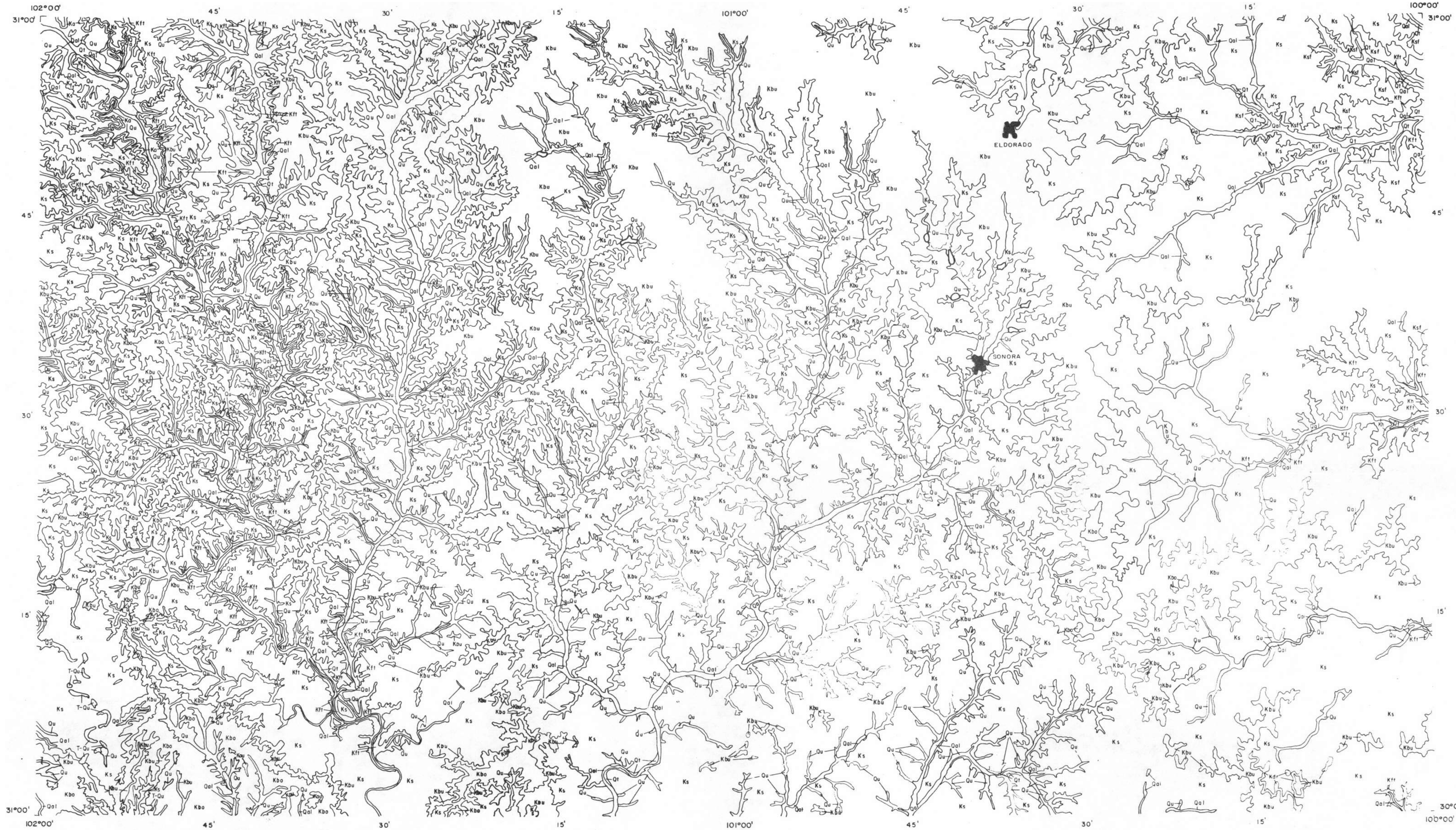
Geodata International, Inc., Dallas, Texas, conducted an airborne gamma ray and total magnetic field survey for the Sonora National Topographic Map Sheet as outlined in Figure I.1. This survey was performed from a fixed-wing aircraft, using a computer-controlled, large-volume radiation detector system to detect the gamma radiation flux emanating from the surface materials. Each map line was flown in an east-west direction with line lengths of 120.0 miles; each tie line was flown in a north-south direction with line lengths of 69.0 miles. Map lines and tie lines are located as shown in Figure II.1.

Sections I through IV of this report present information and results associated with this specific survey. Section V gives the data acquisition and the processing procedures which are generally applicable to any survey flown with the equipment described.

B. SUMMARY of MAP LOCATION, GEOLOGY and PHYSIOGRAPHY

The Sonora map sheet area (Figure I.2) represents a portion of westcentral Texas which is bounded by latitudes $30^{\circ}00'$ to $31^{\circ}00'$ north and longitudes $100^{\circ}00'$ to $102^{\circ}00'$ west. The map region lies within the Edwards Plateau section of the Great Plains physiographic province and as such is characterized by a young plateau which exposes Cretaceous deposits. The plateau typically has a mature margin of moderate-to-strong relief. Quaternary-aged rock comprises approximately 15% of the surveyed area, and Permian exposures are restricted to rivercuts.

Figure I.1 Survey Index Map



GEODATA INTERNATIONAL, INC.
7035 JOHN W. CARPENTER FRWY DALLAS, TEXAS 75247

NATIONAL GAMMA RAY MAP SERIES

Sonora, Texas

GEOLOGY BASE

REF. NTMS, NH 14-4
PREPARED FOR
U.S. DEPARTMENT OF ENERGY

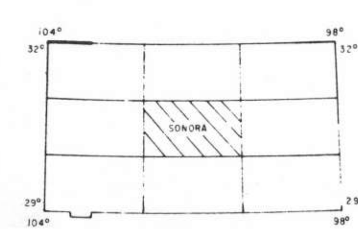


Figure I.2 Geologic Base Map

SECTION II

FLIGHT OPERATIONS

SECTION II.

FLIGHT OPERATIONS

A. SURVEY TIME SUMMARY

The Sonora map sheet was flown between February 20 and March 29, 1980. A detailed list of dates flown and lines flown on those dates, as well as average altitude and speed for those dates, appears in Appendix I.A.

B. LINE COORDINATE LOCATION

Doppler navigation system data have been used to locate the positions of the flight lines. These lines are positioned and verified by point locations, determined by visual sighting by the navigator or photographic recovery, and corresponding record numbers displayed by the on-board computer. The data are then plotted as solid lines with ticks every ten records, circles every fifty records, and record numbers every one hundred records. Record numbers and circles also appear at the end of each line. The points used for location reference (at least every 10 miles) are marked with an "X". The flight base is then photographed with the geologic base map to produce the composite map in Figure II.1.

C. TEST LINES

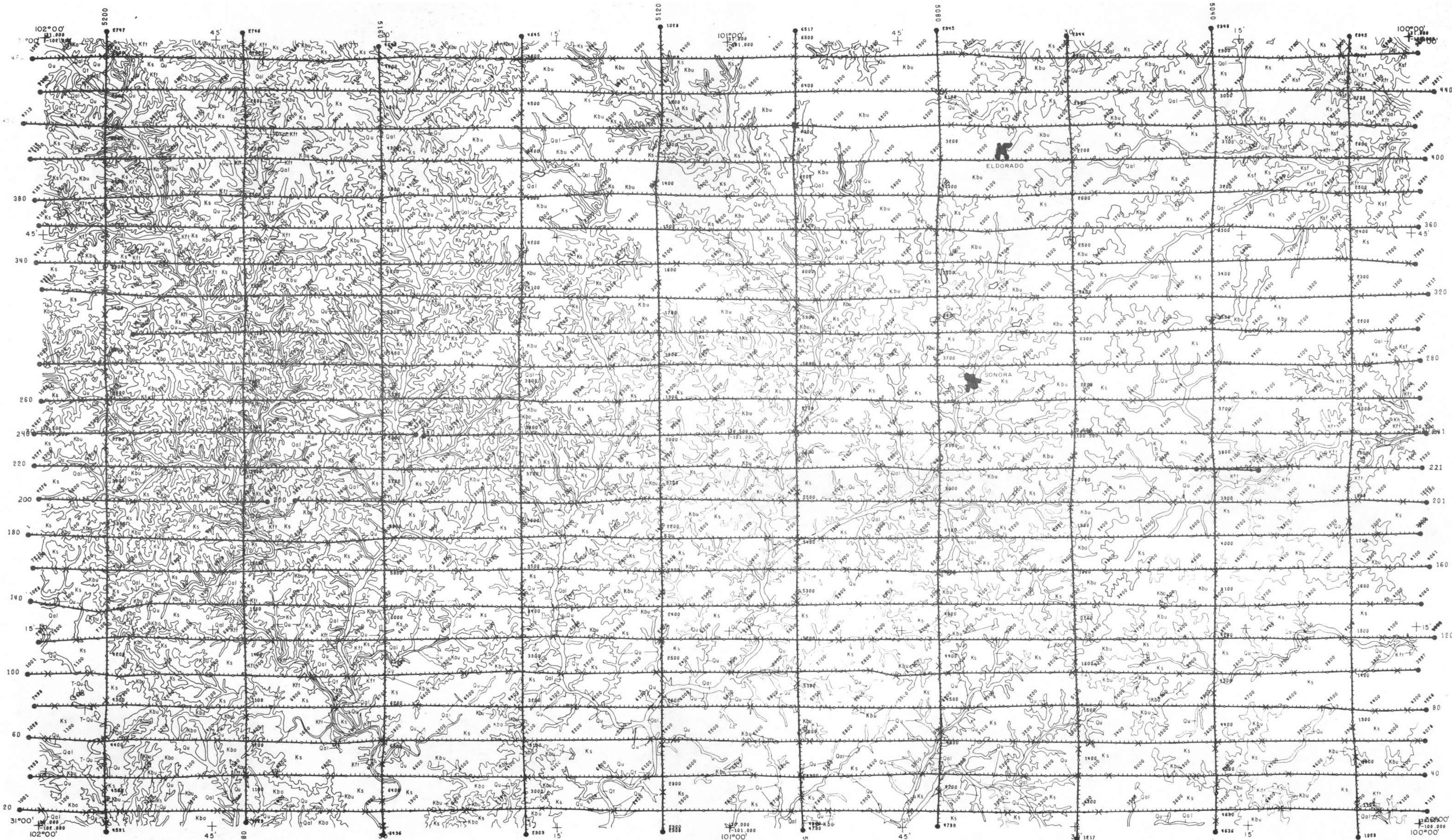
When conditions allow, two five-mile test lines are flown, one at the beginning of the day and one at the end of the day, over the same base. The data are used to check the repeatability of the system's measurements, and are presented in Appendix I.B.

D. MAGNETIC DIURNAL CORRECTION - BASE STATION

A base station magnetometer is set up in the area to acquire data pertaining to the diurnal changes in the magnetic field. These data are analyzed to evaluate a diurnal correction to the magnetic data obtained by the aircraft. A list of these corrections appears in Appendix I.C.

E. ALTITUDE AND GROUND SPEED SUMMARY

The average altitude and ground speed for each line is determined. A list by date appears in Appendix I.A, and is discussed in Section II.A. A list by flight line is given in Appendix I.E.



GEODATA INTERNATIONAL, INC.
7035 JOHN W. CARPENTER FRWY DALLAS, TEXAS 75247

NATIONAL GAMMA RAY MAP SERIES

Sonora, Texas

FLIGHT BASE

REF. NTMS, NH 14-4
PREPARED FOR
U.S. DEPARTMENT OF ENERGY

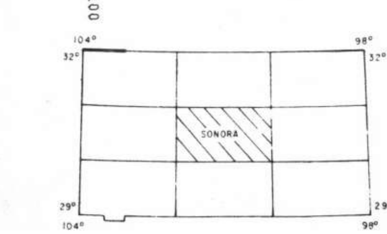


Figure II.1 NTMS Showing Flight Line Location

SECTION III

GEOLOGY OF THE SURVEYED AREA

SECTION III.

GEOLOGY of the SURVEYED AREA

A. LOCATION and GENERAL PHYSIOGRAPHY

The aerial radiometric and magnetic survey was conducted over a portion of westcentral Texas. The Sonora National Topographic Map Sheet (N.T.M.S., 1954) area is bounded by longitudes 100°00' to 102°00' west and latitudes 30°00' to 31°00' north. The map region includes all or portions of Crockett, Edwards, Kimble, Menard, Pecos, Schleicher, Sutton, Terrell and Val Verde counties.

The Sonora map sheet area is located within the Edwards Plateau section of the Great Plains physiographic province. The region is characterized by a young plateau which exposes Cretaceous-aged chemical deposits. The plateau generally has a mature margin of moderate-to-strong relief (Fenneman, 1931).

The Pecos and Devils rivers are the largest fluvial elements in the Sonora map area. There are several minor intermittent streams which also drain the region.

B. GEOLOGY

The depositional and structural history of the Sonora map sheet area (Figure I.2) is reported by Sellards et.al. (1932), Moon (1953), Fowler (1957), Wilson and Majewske (1960), Freeman (1968), and Bay (1977). These data are summarized in the following.

Paleozoic Era

The oldest rocks in the Sonora map area are exposed along river-cuts. Prior to deposition of these Permian-aged units, a major geosyncline reportedly formed (Young, 1968) during Early Pennsylvanian time, and rapidly filled with clastics from a southern source which was synchronously uplifting. Folding and faulting of the "trough" sediments followed during the Pennsylvanian, contemporaneous with the formation of the major uplifts and basins of the foreland area of west Texas.

At the beginning of the Permian Period, orogenic activity recurred along the Marathon belt in the southern border of the map area, and the Val Verde geosyncline, which includes the southwestern half of the map sheet, deepened considerably.

Sand was deposited to the south and closer to the source, while shales and limestones formed in the map sheet area. A major overthrust affected the Val Verde geosynclinal area subsequent to

deposition. The region became relatively stable at the close of the Paleozoic Era.

Mesozoic Era

Triassic and Jurassic exposures are absent from the Sonora map area. The rock record for the Mesozoic begins with the Lower Cretaceous Antlers and Hensell sands. These clastic sediments, along with the overlying chemical deposits of the Edwards Limestone, comprise a simple transgressive series which was deposited in a basin gradually subsiding to the southeast (Fowler, 1957).

The depositional environment during Early Cretaceous time was generally marine, shallow-shelf, with a fluctuating water level. Chemical deposition was interrupted by introduction of the fine-grained clastics of the Del Rio Clay.

After deposition of the Del Rio Clay and prior to deposition of the Buda Limestone, broad, gentle folding produced the Terrell Arch. This structural feature trends through the Sonora map area. It was reportedly responsible for post-Del Rio sedimentation, supplying clastics to the depositional basin.

Cenozoic Era

According to Freeman (1968), it is very probable, though not demonstrable, that regional movements continued to occur during later Cretaceous and almost all of Tertiary time. The relatively few faults in the map area affect units as young as the Upper Cretaceous Boquillas Flags Formation. Terrestrial deposition, in the form of fluvial and alluvial sedimentation, has been active since the Late Tertiary-Early Quaternary.

C. DESCRIPTION of GEOLOGIC MAP UNITS

The following brief descriptions of outcropping units in the Sonora map sheet area (Figure I.2) are given, based on descriptions from Sellards, et.al. (1932) and the Army Map Service (1980).

Cenozoic Era

Quaternary

Qal: Alluvium

Floodplain deposits. This unit includes low terrace deposits near floodplain level and bedrock that is localized in stream channels; gravel, sand, silt, clay, and organic matter.

Qu: Quaternary Deposits, Undivided

Includes alluvial fan deposits, colluvium, caliche, and alluvium. The alluvial fan deposits merge with colluvium and alluvium. They are caliche-cemented, poorly sorted, and contain angular to rounded rock fragments of locally derived material. The caliche also forms partly-alluviated flats, and is predominantly covered by soil.

Qt: Fluviatile Terrace Deposits

Gravel, sand, silt and clay.

Qp: Playa Deposits

This deposit is comprised of clay and silt that is sandy, light-grey in color, and is found in shallow depressions. The deposits are typically covered by a thin layer of Recent sediment.

Tertiary-Quaternary

T-Qu: Uvalde Gravel

Caliche-cemented gravel. Some boulders in the gravel are up to 1 foot in diameter. Well-rounded pebbles and cobbles of chert, along with some cobbles of quartz and limestone, are present. The unit characteristically occupies a high abandoned stream channel along Big and Meyers canyons in the southwestern part of the sheet.

Mesozoic Era

Cretaceous

Kau: Austin Chalk

The unit ranges from a hard, lime mudstone to soft chalk. Predominantly composed of microgranular calcite with minor Foraminifera tests and *Inoceramus* prisms; sparsely glauconitic. Pyrite nodules that are partly weathered are common. It is greyish-white- to white-colored, and is locally highly fossiliferous. Only the lower portion of the unit is present.

Kbo: Boquillas Flags

This unit is comprised of four units. The upper unit is predominantly shale which is silty and medium-grey, and it is interbedded with some limestone which is nodular to laminar, granular, and brownish-grey. The second unit is shale which is silty and medium-grey, and it is interbedded with a granular, yellowish-grey limestone. The third unit is represented by a dark-grey, silty shale which is interbedded with laminated siltstone. The shale grades upward to silty limestone. The basal unit is clastic limestone with thin, cross-laminated beds that pinch and swell along strike. The limestone is interbedded with siltstone which is light yellowish-grey to greyish-orange in color. Total thickness is approximately 200 feet.

Kbu: Buda Limestone

This unit is comprised of fine-grained, bioclastic limestone that is generally glauconitic, pyritiferous, hard and massive. It is poorly bedded to nodular and thinner bedded and argillaceous near the upper contact; light-grey to pale orange in color, weathers to dark-grey to brown. Burrows in the limestone are filled with chalky marl. The basal beds are typically composed of marly, nodular limestone and thin, yellow marl beds with scarce *Budaiceras* fossils. Thickness of the formation is greater than or equal to 50 feet. The Buda Limestone forms much of the plateau surface.

Kdr: Del Rio Clay

Calcareous and gypsiferous clay. Pyrite is abundant in the unit. The Del Rio Clay is blocky, medium-grey, and weathers to a light-grey or yellowish-grey color. Marine megafossils are present, and include abundant *Exogyra arietina* and other pelecypods. Thickness of the unit is greater than or equal to 20 feet. It feathers out northward.

Ks: Segovia Member of the Edwards Limestone

This unit is comprised of limestone and dolomite. The upper portion is cherty, light-grey, miliolid, shell fragment, rudistid limestone. The middle portion is represented by dolomite that is porous, massive to thin-bedded, cherty, medium brownish-grey in color, and contains collapse breccia. The lower portion is composed of light yellowish-grey, miliolid limestone and marl and marly limestone with *Exogyra texana* and oxytropidocerid ammonites. Thickness of the formation is approximately 300 feet.

Ksf: Lower Part of the Segovia Member and Upper Part of the Fort Terrett Member, Undivided

Kft: Fort Terrett Member of the Edwards Limestone

Limestone and dolomite comprise this unit. The upper portion contains porcelaneous aphanitic limestone with collapse breccia, chert, and recrystallized limestone. The middle portion is light- to dark-grey, cherty, miliolid, shell fragment, rudistid limestone and medium brownish-grey dolomite. The lower portion is composed of nodular limestone with thin, yellow, *Exogyra texana*-bearing clay at the base. Thickness of the unit ranges from 150 to 300 feet, thickening southward.

Ka: Antlers Sandstone

Fine-grained, calcareous sandstone that is well-cemented to friable, massive to bedded, and white to yellow and reddish in color. Exposed along the Pecos River. Up to approximately 50 feet thick.

Kh: Hensell Sand

This unit is composed of sand, silt, and clay. It is mostly friable, except where it is calcareous. Red and grey in color. Outcrop thickness is 90 feet; the base of the unit is not exposed.

P: Permian Rocks, Undivided

Present locally along the Pecos and San Saba rivers and north of North Llano River. Along the Pecos River, it consists of massively bedded limestone, flanked on either side by interbedded, thin-bedded limestone and shale. Approximately 150 feet thick. Along the San Saba River near the eastern edge of the sheet and along Epps Creek north of North Llano River, the unit consists of limestone and dolomite.

D. RADIOACTIVE MINERAL PROSPECTS in the SURVEYED AREA

The Southern Interstate Nuclear Board (1969) reports a uranium prospect in carbonaceous material in Edwards County, south of the Sonora map area. Uranium mineralization is associated with calcite in solution cavities in Val Verde County, south of the map sheet. There are no known occurrences directly within the area, however.

SECTION IV

RESULTS OF DATA ANALYSIS

SECTION IV.

RESULTS OF DATA ANALYSIS

A. DESCRIPTION OF STACKED DATA PROFILES

1. Multivariable Radiometric Stacked Data Profiles

These profiles are presented at a horizontal scale of 1:500,000. The vertical scales are:

Altitude: 100 feet/div.; aircraft altitude above the surface

TL(^{208}Tℓ)* 1.0 ppm/div; 7.15 c/s = 1 ppm/eTh

BI(^{214}Bi)* .3 ppm/div; 13.52 c/s = 1 ppm/eU

K (^{40}K)* .20 %/div; 98.06 c/s = 1%K

BiAir 5.0 c/s/div. 50 seconds averaged

Residual Magnetic Field 100 gammas/div. (See Sec.V.B.1)

GC (Count from 400 keV to 3.0 MeV) 400 c/s/div.

Bi/TL .07/div.

Bi/K .5 /div.

TL/K .9 /div.

Geology Strip: An approximate six-mile width of the geology map, containing each line, is displayed above the profiles.

* 7-second average weighted 1:2:3:4:3:2:1 is used and plotted at center.

2. Residual Magnetic Field Profiles

Altitude: 100 feet/div.

Temperature: 2 ^{o}C/div.

Pressure: 3 mm of Hg/div.

Base Magnetic Field: 10 gammas/div.

Residual Magnetic Field: 10 gammas/div.

Geology Strip: An approximate six-mile width of the geology map, containing each line, is displayed above the profiles.

All profiles appear in Section IV.H.

B. SINGLE AND AVERAGE RECORD LISTINGS

Single and average record listings are provided on microfiche. Samples of each type are presented in Appendix III.

C. STATISTICAL PRESENTATION OF DATA BY GEOLOGIC TYPE

Tables IV.(1-6) contain the average value of each variable as a function of line number and geologic type. The tables are in order eTh, eU, K, eU/eTh, eU/K, eTh/K.

D. FREQUENCY DISTRIBUTON OF DATA FOR EACH GEOLOGIC TYPE

Table IV.7 contains the mean, standard deviation, and number of events for each geologic type encountered over the entire map sheet. Histograms for these data appear in Section IV.H.2.

E. DATA INTERPRETATION

1. Analysis of Geologic Histograms

The radioactivity data is shown in histogram form with parts per million or percent plotted against number of events (Appendix I). The histograms for ^{208}Tℓ and ^{40}K were examined for conformity to a Gaussian curve. It is generally assumed that a geologic map unit, which encompasses a fairly homogeneous lithology, would have a unimodal distribution. Where map units vary significantly from a unimodal distribution, a further subdivision into more homogeneous lithologic types may be recommended. Table IV.8 shows the map units, which vary from a unimodal model, and for which separation of two or more distributions is feasible. Only units with excess of 200 events are considered.

2. Discussion of Anomalies

Introduction

The ^{208}Tℓ, ^{214}Bi, and ^{214}Bi/^{208}Tℓ (ratio) data were examined for anomalous values. An anomaly is defined by a minimum of two adjacent, two-standard deviation values, or a single, three-standard deviation value. The anomalies were listed by flight line in Table IV.9; by geologic map unit in Table IV.10; Table IV.10 is statistically summarized in Table IV.11. Only positive anomalies were examined for ^{208}Tℓ and ^{214}Bi, but both positive and negative values were studied for the ratio anomaly.

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Table IV.1 Geologic Unit Average Value as a Function of Map Line for eTh (PPM Times 10)

LINE / UNIT:	QAL	QU	QT	QP	TQU	KAU	KBO	KBU	KDR	KS	KSF	KFT	KA	KH	P
ML 20:	33	32			42	29	37	36	49	26		25			
ML 40:	32	34	30		30	55	46	38	43	27		20			27
ML 60:	34	43			25		48	44	33	31		20			
ML 80:	34	38			26		50	42	42	31		34			
ML 100:	50	42	19		21		46	39	26	31		21			
ML 120:	27	41					53	44		32		25			
ML 140:	34	36					61	50		32		15			
ML 160:	42	42						56		34		21			
ML 180:	45	45					59	45		37		30			
ML 200:	26	31						33		29		18			
ML 201:	56	48						42		35					
ML 220:	49	36						45		35		23			
ML 221:	45	35								31		36			
ML 240:	31	36						36		32		28			
ML 241:	60	41					62	48		38		34		37	
ML 260:	45	44					35	46		37		37			
ML 280:	52	48					60	57		40	42	37	24		
ML 300:	57	47					57	62		41		26			
ML 320:	56	43					54	70		40		29	41		
ML 340:	64	50						70		41	60	27	24		
ML 360:	59	54	37					70		41	61	31			
ML 380:	60	49						74		43	55	25	27		
ML 400:	64	53	54					72		41	48	43	38		
ML 420:	71	58	55					75		42	43	38	25		
ML 440:	62	55	54					79		46	60	33	29		
ML 460:	69	55	45					78		46	59	47	22		
TL 5020:	61	38	61					59		37	52	36		28	
TL 5040:	42	38						51		41					
TL 5060:	46	46					50	60		42					
TL 5080:	40	33						72		34					
TL 5100:	57	42						76		32					
TL 5120:	38	43						64		32					
TL 5140:	47	47					43	54		33					
TL 5160:	54	46						50		29		17			
TL 5180:	43	43				26	42	38		24		28			
TL 5200:	34	39	52		29		32	31		25		27	25		

SONORA

Table IV.2 Geologic Unit Average Value as a Function of Map Line for eU (PPM Times 10)

LINE / UNIT:	QAL	QU	QT	QP	TQU	KAU	KBO	KBU	KDR	KS	KSF	KFT	KA	KH	P
ML 20:	17	19			42	9	30	19	12	14		11			
ML 40:	14	15	11		26	25	34	19	20	14		11			13
ML 60:	18	22			19		39	17	10	15		12			
ML 80:	15	15			19		41	18	13	16		19			
ML 100:	16	15	19		21		35	17	15	16		14			
ML 120:	16	16					19	17		15		14			
ML 140:	17	14					14	17		15		14			
ML 160:	14	14						15		15		14			
ML 180:	16	14					24	16		13		16			
ML 200:	12	15						21		17		13			
ML 201:	16	15						15		14					
ML 220:	15	15						16		15		15			
ML 221:	18	15								14		15			
ML 240:	14	16						17		16		15			
ML 241:	17	14					17	15		14		14		12	
ML 260:	17	14					26	18		14		12			
ML 280:	15	16					18	17		14	16	12	15		
ML 300:	16	15					20	15		13		14			
ML 320:	18	16					18	15		13		15	15		
ML 340:	15	14						16		13	11	14	13		
ML 360:	17	16	14					14		13	14	15			
ML 380:	16	15						13		13	13	16	18		
ML 400:	15	17	11					14		13	14	14	16		
ML 420:	15	15	12					15		13	14	13	16		
ML 440:	15	15	15					16		13	13	14	13		
ML 460:	17	15	15					15		12	12	16	14		
TL 5020:	16	11	17					13		13	14	12		11	
TL 5040:	13	11						15		13					
TL 5060:	16	15					15	18		16					
TL 5080:	17	13						18		14					
TL 5100:	20	16						17		15					
TL 5120:	20	15						17		15					
TL 5140:	18	17					28	17		16					
TL 5160:	17	17						17		15		14			
TL 5180:	16	17				14	31	20		15		15			
TL 5200:	18	19	20		25		16	19		19		16	14		

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Table IV.3 Geologic Unit Average Value as a Function of Map Line for K (PC Times 100)

LINE / UNIT:	QAL	QU	QT	QP	TQU	KAU	KBO	KBU	KDR	KS	KSF	KFT	KA	KH	P
ML 20:	39	40			56	51	53	39	51	25		25			
ML 40:	44	46	46		40	80	61	40	43	27		24			27
ML 60:	48	56			36		67	53	42	33		28			
ML 80:	49	48			31		59	51	47	37		48			
ML 100:	79	58	19		31		62	48	26	37		26			
ML 120:	40	57					73	56		40		33			
ML 140:	53	49					85	65		40		26			
ML 160:	65	61						74		43		27			
ML 180:	66	66					82	58		46		45			
ML 200:	38	45						45		42		29			
ML 201:	89	71						59		43					
ML 220:	84	49						62		44		30			
ML 221:	65	44								36		41			
ML 240:	53	56						47		43		38			
ML 241:	94	60					91	62		47		43		53	
ML 260:	77	65					45	63		46		50			
ML 280:	88	73					98	80		51	68	47	26		
ML 300:	102	70					85	90		52		36			
ML 320:	93	69					78	101		51		41	85		
ML 340:	101	80						102		52	85	40	32		
ML 360:	105	85	66					102		53	80	43			
ML 380:	96	81						113		57	73	35	43		
ML 400:	92	88	79					108		58	61	64	62		
ML 420:	125	98	80					111		58	58	59	39		
ML 440:	104	93	130					118		65	84	53	55		
ML 460:	121	98	100					116		65	83	87	41		
TL 5020:	87	46	89					66		41	69	44		38	
TL 5040:	53	43						61		48					
TL 5060:	61	60					69	76		47					
TL 5080:	53	41						97		39					
TL 5100:	86	60						105		38					
TL 5120:	63	56						93		39					
TL 5140:	68	65					39	77		40					
TL 5160:	88	75						71		41		19			
TL 5180:	78	70				45	68	46		31		42			
TL 5200:	54	62	105		34		43	42		31		42	40		

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Table IV.4 Geologic Unit Average Value as a Function of Map Line for eU/eTh (Times 100)

LINE / UNIT:	QAL	QU	QT	QP	TQU	KAU	KBO	KBU	KDR	KS	KSF	KFT	KA	KH	P
ML 20:	51	60			99	32	82	59	25	60		48			
ML 40:	46	47	39		85	47	76	53	48	59		68			49
ML 60:	54	52			76		81	43	32	54		79			
ML 80:	49	43			76		82	47	32	58		58			
ML 100:	39	40	100		100		76	50	62	56		76			
ML 120:	66	44					45	45		55		67			
ML 140:	62	46					24	38		52		107			
ML 160:	39	40						30		49		76			
ML 180:	44	34					45	41		41		64			
ML 200:	56	55						74		60		82			
ML 201:	33	36						39		44					
ML 220:	32	47						38		46		72			
ML 221:	41	43								48		45			
ML 240:	52	54						50		52		55			
ML 241:	34	38					28	34		40		44		35	
ML 260:	45	39					74	42		40		37			
ML 280:	29	37					32	33		37	38	34	64		
ML 300:	35	36					37	26		36		63			
ML 320:	36	43					33	23		36		55	37		
ML 340:	25	33						23		37	19	58	58		
ML 360:	34	36	44					22		37	23	55			
ML 380:	28	36						18		36	25	69	69		
ML 400:	25	35	22					20		35	31	38	43		
ML 420:	22	28	24					22		35	34	38	62		
ML 440:	26	30	28					20		31	23	50	44		
ML 460:	26	30	35					20		27	21	39	64		
TL 5020:	26	30	28					23		38	28	34		39	
TL 5040:	33	31						30		33					
TL 5060:	35	33					31	31		42					
TL 5080:	47	43						26		45					
TL 5100:	38	43						24		50					
TL 5120:	55	39						29		57					
TL 5140:	42	39					67	34		53					
TL 5160:	36	42						39		64		89			
TL 5180:	44	49				54	77	57		68		66			
TL 5200:	60	53	40		86		51	66		83		64	61		

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Table IV.5 Geologic Unit Average Value as a Function of Map Line for eU/K (Times 1000)

LINE / UNIT:	QAL	QU	QT	QP	TQU	KAU	KBO	KBU	KDR	KS	KSF	KFT	KA	KH	P
ML 20:	4762	5692			7926	1925	5954	5722	2392	6605		5188			
ML 40:	3719	4223	3226		6486	3225	6383	5266	4901	6395		5624			4968
ML 60:	4059	4225			5423		6168	3680	2681	5160		7098			
ML 80:	3646	3527			6404		7208	3864	3078	5097		4244			
ML 100:	2453	3133	11975		6961		5909	4089	6599	4875		6861			
ML 120:	4851	3368					3263	3571		4591		5215			
ML 140:	4057	3552					1729	3164		4303		7028			
ML 160:	2674	2840						2341		4038		5729			
ML 180:	3403	2603					3236	3195		3441		5603			
ML 200:	4158	4086						5964		4543		5695			
ML 201:	2119	2614						2876		3624					
ML 220:	2058	3728						2942		3828		6629			
ML 221:	2883	3543								4336		4123			
ML 240:	3637	3976						4069		3969		4306			
ML 241:	2453	2809					1916	2689		3375		3647		2547	
ML 260:	2910	2713					5755	3209		3304		2757			
ML 280:	1914	2590					2144	2442		3005	2401	2851	6192		
ML 300:	2175	2610					2493	1860		2930		4509			
ML 320:	2342	2918					2390	1636		2870		4357	1837		
ML 340:	1683	2268						1645		2942	1367	4326	4370		
ML 360:	2025	2506	3235					1533		2880	1837	4475			
ML 380:	1789	2372						1262		2711	1967	5222	4370		
ML 400:	1781	2328	1545					1414		2564	2545	2726	2693		
ML 420:	1379	1795	1702					1521		2608	2677	2586	4193		
ML 440:	1624	1864	1191					1410		2195	1680	3379	2455		
ML 460:	1526	1750	1574					1396		1961	1542	2542	3584		
TL 5020:	1932	2504	1983					2131		3633	2155	2945		2981	
TL 5040:	2774	2968						2584		2998					
TL 5060:	2715	2667					2231	2559		4132					
TL 5080:	3801	3751						1987		4338					
TL 5100:	2825	3395						1772		4592					
TL 5120:	3264	3299						2110		5211					
TL 5140:	3178	3179					7696	2712		4951					
TL 5160:	2635	3102						2979		5391		9206			
TL 5180:	2447	3436				3154	4921	4874		5889		4941			
TL 5200:	4211	3845	2133		7449		3801	5092		7194		4748	4492		

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Table IV.6 Geologic Unit Average Value as a Function of Map Line for eTh/K (Times 1000)

LINE / UNIT:	QAL	QU	QT	QP	TQU	KAU	KBO	KBU	KDR	KS	KSF	KFT	KA	KH	P
ML 20:	9259	9040			7948	5844	7433	9602	9619	11127		10448			
ML 40:	7805	8667	7491		7610	6875	8345	9906	10191	10904		8364			10170
ML 60:	7344	8167			7144		7528	8553	8070	9605		8358			
ML 80:	7510	8215			8751		8719	8288	9235	8828		7423			
ML 100:	6386	7593	11968		6985		7733	8307	10637	8732		8967			
ML 120:	7328	7561					7342	7934		8409		7880			
ML 140:	6638	7770					7186	8046		8423		6503			
ML 160:	6753	7103						7719		8232		8005			
ML 180:	7332	7341					7262	7800		8352		7916			
ML 200:	7693	7376						7801		7558		6838			
ML 201:	6387	7135						7328		8343					
ML 220:	6097	7947						7597		8326		9163			
ML 221:	6982	8130								9084		9038			
ML 240:	6582	6959						8039		7657		7791			
ML 241:	6825	7271					6837	7924		8333		8207		7167	
ML 260:	6128	7024					7727	7522		8282		7673			
ML 280:	6396	6941					6381	7272		8157	6274	8218	9518		
ML 300:	5887	7048					6711	7087		8126		7258			
ML 320:	6322	6693					7115	7044		8082		7699	4886		
ML 340:	6603	6722						6996		8006	7024	7205	7553		
ML 360:	5791	6697	6643					6924		7864	7778	7989			
ML 380:	6408	6384						6661		7644	7689	7571	6286		
ML 400:	7090	6382	7041					6811		7357	8198	6968	6226		
ML 420:	6064	6125	6925					6899		7479	7758	6683	6702		
ML 440:	6258	6200	4197					6773		7171	7186	6759	5598		
ML 460:	5957	5910	4512					6776		7249	7173	5988	5589		
TL 5020:	7200	8477	6985					9058		9317	7622	8537		7508	
TL 5040:	8264	9588						8408		8951					
TL 5060:	7652	7984					7243	8074		9491					
TL 5080:	7882	8699						7498		9342					
TL 5100:	7184	7565						7276		9108					
TL 5120:	5946	8169						7031		8896					
TL 5140:	7204	7841					11401	7506		9051					
TL 5160:	6777	6869						7400		8232		10512			
TL 5180:	5563	6819				5754	6461	8474		8629		7405			
TL 5200:	6860	6940	5222		8586		7455	7685		8559		7228	7016		

eTh		eU		K		eU/eTh		eU/K		eTh/K		MAX. NO. EVENTS	GEOL. UNIT
σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$		
2.0487	5.2	0.4414	1.7	0.3932	0.8	0.2089	0.3778	1.7027	2.5753	1.6033	6.6837	3913.0	QAL
1.7182	4.5	0.5290	1.6	0.3459	0.7	0.1974	0.4037	1.8613	2.9547	1.9000	7.1733	10789.0	QU
1.3175	5.1	0.4631	1.5	0.3267	0.9	0.1639	0.3198	2.1387	2.1676	2.0247	6.4072	295.0	QT
1.0836	3.8	1.5040	3.6	0.1727	0.5	0.2672	0.9430	2.6720	7.5771	1.9319	8.0826	362.0	TQU
1.2127	3.3	0.7174	1.4	0.1628	0.5	0.1545	0.4103	1.0100	2.4749	0.7359	5.9738	73.0	KAU
1.2675	4.7	1.3066	3.0	0.2336	0.6	0.3012	0.6891	2.7387	5.3767	2.3125	7.8024	1777.0	KBO
1.9816	6.1	0.4498	1.7	0.3278	0.9	0.1719	0.3104	1.5827	2.3643	1.3598	7.4153	15997.0	KBU
1.0298	4.0	0.3744	1.4	0.1254	0.4	0.1903	0.3830	2.2582	3.7896	1.8129	9.6737	221.0	KDR
1.2176	3.6	0.4080	1.5	0.1914	0.4	0.2428	0.4703	2.4724	4.0567	2.2373	8.5897	50122.0	KS
1.2604	5.4	0.3555	1.4	0.2032	0.7	0.0912	0.2667	0.7724	2.0248	1.1438	7.5768	1056.0	KSF
1.2526	3.1	0.3903	1.5	0.2286	0.4	0.2957	0.5596	2.7701	4.3612	2.2683	7.7794	2728.0	KFT
1.0448	3.1	0.3475	1.5	0.2411	0.5	0.1740	0.5340	1.6924	3.5746	1.5686	6.4730	122.0	KA
0.8208	3.6	0.2716	1.2	0.1452	0.5	0.1268	0.3616	0.9673	2.6006	1.2645	7.2092	49.0	KF
0.5529	2.7	0.3777	1.3	0.0887	0.3	0.0449	0.4900	0.5289	4.9683	1.4590	10.1700	6.0	P

Table IV.7 Mean ($\bar{X}$) and Standard Deviation (σ) for Each Geologic Type.

TABLE IV.8 Geologic Units with Apparent Significant Variations from Unimodal Distributions, Based on the Analysis of the eTh Histograms*

Geologic Unit	No. Events	^{208}Tl Recommended Split (equivalent ppm)
Qal	3913	none
Qu	10789	none
Qt	295	none
T-Qu	362	none
Kbo	1777	none
Kbu	15997	none
Kdr	221	none
Ks	50122	none
Ksf	1056	none
Kft	2728	none

*Recommended Splits on the Histograms are Given Only Where Such Splits Appear to be Obvious.

TABLE IV.9 SUMMARY OF ANOMALIES
SONORA

		208 TL		214 BI		214/208 BI/TL
ML20			QAL	1056	KBU	1231
			KS	1241- 1251	KS	1241- 1251
			KBU	1266- 1271	KBU	1266- 1271
				1386- 1391		1281
			QAL	1501		1291- 1301
			QU	1506		1386- 1391
				1546- 1566	QU	1546- 1561
			KBU	2011- 2021	KBU	1736- 1751
					KS	1766
						1781
					KBU	1796- 1801
					KS	1816- 1861
					KBU	2021
						2031- 2046
					QU	2336- 2341
					KS	2701
						3081
ML40			KS	5989- 5994	KS	5419- 5424
			KBU	6914		5459- 5464
				6924- 6929	QU	5799
			QU	6949	KS	6014- 6019
				6994	KBU	6324- 6334
				7024- 7034		6539
			KBO	7049- 7054	KS	6549- 6554
				7104- 7109		6689- 6699
			KBU	7149		6709
			KBU	7184- 7189		6724- 6734
			KS	7234	KBU	6784- 6794
				7244		6924- 6929
				7254- 7274	KBO	7099- 7109
				7284		7119
				7299- 7314	KBU	7149
						7159
					KS	7234
						7254- 7274
						7294- 7314
					KBU	7319- 7324
ML60	KS	3653- 3658	QU	1053	QU	1053
			KS	1063- 1078	KS	1068- 1078
				1093- 1128		1098
				1178- 1208		1113- 1118
			KBU	1253- 1258		1128
			QU	1328- 1373		1178- 1208
				1403	KBU	1233- 1238
			KBU	1503		1248- 1258

(...) DENOTES NEGATIVE ANOMALY

(TABLE IV.9 CONT'D)

		208 TL		214 BI		214/208 BI/TL
ML60					QU	1353- 1373
					KBU	1503
					KS	1573
						1703
						1718- 1723
						1793- 1803
						2258
						2328
						2348
ML80	KS	7053- 7058	KS	6458- 6468	KS	5908- 5913
			KFT	7123- 7128		5958- 5963
			KBU	7223- 7233		6003
			KS	7263- 7303		6083- 6088
				7338- 7353	QAL	6173
				7423- 7473	KS	6468
					KBU	6603- 6608
					KS	6633- 6638
						6718- 6723
						6733- 6738
						6753- 6768
						6813- 6828
						6838
						6923
						6958- 6963
					KBU	7223- 7233
					KS	7293- 7313
						7363- 7368
						7413- 7438
						7468- 7473
ML100	KS	3786- 3796	KS	1021- 1041	KS	1021- 1031
				1056- 1081		1071- 1076
				1141- 1176		1101
			KBU	1241- 1246		1146- 1171
			KS	1291- 1296	KBU	1206- 1226
				1361- 1366		1241- 1246
					QT	1631- 1636
					KS	1661
					QAL	1696- 1701
					KS	1716- 1721
						1731
					KBU	1781
						1946- 1951
						2036- 2041
					KDR	2371
						2406- 2411

(...) DENOTES NEGATIVE ANOMALY

(TABLE IV.9 CONT'D)

		208 TL		214 BI		214/208 BI/TL
ML100						
ML120	KS	4488- 4493	KS	5853- 5858	QU	5808
	KBO	4788- 4793			KBU	5948- 5953
			KS	7103- 7113	KS	5963
				7158- 7188	KBU	6163
				7198- 7203	KS	6343- 6348
						6403- 6413
						6423- 6438
						6463- 6468
						6553- 6558
						6568- 6578
						6623
						6648- 6653
					KFT	6683
					KS	6713- 6723
					QAL	6798- 6803
					KS	6813- 6823
					QAL	6848- 6853
					KBU	6893- 6903
						6928- 6938
						7003- 7008
						7033- 7038
						7048
						7063
					KS	7083- 7093
						7113- 7123
						7158
						7168- 7178
ML140			KBU	1176- 1193	QAL	1058- 1068
				1843- 1848	KBU	1178- 1198
						1258
						1268
					KS	1278- 1283
					QU	1288
					KS	1328- 1333
						1398
					QAL	1453- 1458
					KS	1473- 1478
					QU	1488
					KFT	1493- 1498
					KS	1518- 1523
						1538
					KBU	1838- 1848
						1908
					QU	2603
					KS	2618

(...) DENOTES NEGATIVE ANOMALY

(TABLE IV.9 CONT'D)

		208 TL		214 BI		214/208 BI/TL
ML140						
ML160	KS	4236- 4241	KS	7031- 7036	KBU	6601- 6606
		4291- 4296			KS	6686- 6691
		4351- 4356				6741- 6751
		4996			KFT	6756- 6761
					QU	6791- 6801
					KS	6856
						6901
						6926- 6931
						6986- 6996
					QAL	7021
					KS	7061- 7066
					KBU	7106- 7111
ML180	QAL	1766-1771	KBU	71- 76	KBU	71- 76
	KBO	2356- 2361		131		131
	KS	2501- 2506				271- 276
		2596- 2601				336- 341
		2846			KS	501- 511
					QAL	546- 551
					KS	571
					KBU	676
					QAL	896- 901
ML201	KS	1495- 1500				
		2815- 2820				
ML200			KS	3970- 3975	KFT	3780
						3795- 3800
					KS	3900- 3905
					KBU	3955- 3965
					QU	4020- 4025
						4035
ML220			KBU	4497- 4502	QU	4602- 4607
				4507- 4512	KS	4627
			KS	5467- 5472		4787
ML221						
ML241	KBU	2000-2205	KS	1799		
	KS	2339- 2344				
		2389- 2394				
		2759				
ML240			KS	4447	QU	3807
					KBU	4152- 4157
					QU	4312

(...) DENOTES NEGATIVE ANOMALY

(TABLE IV.9 CONT'D)

		208 TL		214 BI		214/208 BI/TL
ML240					KBU	4347
					QU	4372- 4377
					KBU	4462
ML260	KS	3233- 3238	KBU	1258- 1263	QU	1033- 1038
		3563- 3568	KS	2763	QAL	1173- 1183
					KBU	1273
						1438
						1483- 1488
					QU	1618- 1623
ML280	KS	4644- 4649	KBU	6839- 6844	KBU	6839- 6844
		4919- 4944		6854- 6864		6859- 6864
		4964- 4969			QU	6894
	QU	5809- 5814				
	KS	5819- 5824				
	QAL	5884				
	KBU	6064- 6069				
	KBU	6804- 6814				
ML300	KS	1701			KS	1361
	QU	1776- 1786			KFT	1511
	KS	2406- 2411			QAL	1521
		3651- 3666				
		3681- 3686				
		3886- 3891				
	KBU	2531				
ML320	KS	1632- 1637			KS	3977
		2002- 2012			QU	4262- 4272
		3802- 3807				
ML340	QU	5307- 5317	KS	5402- 5407		
	KS	5602- 5607				
		6197- 6202				
		6592- 6612				
		7122- 7137				
	QAL	6017-6022				
ML360	KS	1766	KS	3786- 3791	QAL	4031
	QU	2286- 2291			QU	4126
	KS	2301- 2306				
	QU	2416- 2421				
	KS	2431- 2436				
	KFT	4066- 4076				
ML380	QU	4881- 4891	KSF	6706	QU	4371
	KS	5031				

(...) DENOTES NEGATIVE ANOMALY

(TABLE IV.9 CONT'D)

		208 TL		214 BI		214/208 BI/TL
ML380	KS	5221- 5226				
		5236				
		5606				
		5951- 5956				
		6071- 6076				
		6166- 6221				
		6591- 6596				
ML400	KFT	1259	KSF	1384-1389		
		1390-1399				
	KS	1944- 1949				
		2344- 2349				
		2694- 2699				
		2729- 2739				
		2849				
	QU	3544- 3549				
	KS	3574- 3579				
ML420	QU	5053- 5058	KBU	5318- 5323	KS	4638- 4643
		5093- 5098			KBU	4708- 4713
	KS	5258- 5263			KSF	7183
		5643- 5653				
	QU	5788- 5803				
	KS	6723- 6728				
		6968- 6973				
ML440	QAL	4106- 4111				
	KSF	4126- 4131				
	KS	4281- 4286				
		4446- 4451				
		4526				
		4811- 4816				
		6036- 6041				
	QU	6361- 6366				
	KS	6371				
	QU	6641- 6646				
		6656- 6661				
	KFT	6666				
	QAL	4521				
ML460	KFT	1483- 1498				
	QU	1843- 1853				
		2038- 2043				
	KS	2048				
		2083- 2088				
		2483				
		3053- 3058				
		3523- 3528				

(...) DENOTES NEGATIVE ANOMALY

(TABLE IV.9 CONT'D)

		208 TL		214 BI		214 BI/ 208 TL
ML460	KS	3663				
		3693- 3698				
	QU	3279-3284				
TL5020	KS	1618- 1623				
		1738				
		2308- 2313				
TL5040	KS	3301				
		3391- 3396				
		3506- 3516				
		3766- 3771				
TL5060	KS	2377- 2382	KBU	2257- 2282		
		2447- 2462	KS	2777- 2782		
		2522- 2532				
		2877- 2882				
TL5080	KS	3360			KS	4750- 4755
		3485				4780
TL5100			QAL	6110- 6115		
TL5120	KS	1163			KS	2498
		1278- 1283				2608- 2613
						2623- 2638
						2658- 2668
						2713
						2768
						2798
						2823
TL5140	KS	4609- 4619	KS	2924- 2939	KS	2929- 2934
	QU	4624- 4629	KBO	3084- 3089	KBU	3144- 3149
			KS	3609- 3619		
			QAL	3679		
			KBU	4479		
TL5160	KS	4696- 4701	KS	4701	KS	5641
	QU	4786- 4791	QAL	4851		5791
	KS	4796- 4806	KS	4926- 4931	QU	5871
	QU	4856- 4861		5031	KS	5961
	KS	4926- 4941		6126	KBU	5986
		5001- 5016			KS	6021- 6026
						6041
						6056- 6061
					KBU	6131- 6136
					KFT	6236- 6241

(...) DENOTES NEGATIVE ANOMALY

(TABLE IV.9 CONT'D)

		208 TL		214 BI		214 BI/ 208 TL
TL5160					KS	6256- 6276
						6286
					KFT	6291- 6296
					KS	6301- 6306
						6336- 6346
						6381- 6391
						6456- 6461
TL5180	QU	2533- 2538	KBU	1178- 1183	KBU	1178- 1183
	KFT	2623		1218- 1223	KS	1418
			KS	1948	KFT	1428
					KS	1448- 1458
						1488- 1493
						1523- 1538
						1563
						1583
					KFT	1593
					QU	1663
					KS	1688- 1693
					QU	1728- 1738
					KFT	1748- 1753
					KBU	1963
					QU	2003
TL5200			KS	3657- 3662	KBU	3072
			KBU	3712- 3717		3092- 3097
			KS	4242- 4262	KS	3142- 3147
				4272- 4282	QU	3182
				4292- 4342	QAL	3262
				4362- 4377	KS	3267- 3272
				4392- 4412	KBU	3452- 3457
				4447- 4462		3992
				4487- 4512		4027- 4032
					KS	4067- 4072
					KBU	4087- 4117
					KS	4132
						4142- 4147
						4207
						4222- 4252
						4272- 4282
						4292- 4302
						4317- 4327
						4337- 4342
						4362- 4372
						4392- 4412
						4452- 4512
					KBU	4517
						4527- 4532

(...) DENOTES NEGATIVE ANOMALY

TABLE IV.10 Radioactivity Anomalies per Geologic Map Unit

Geologic Unit	^{208}Tl	^{214}Bi	$^{214}Bi/^{208}Tl$
<u>Quaternary</u>			
Qal	5	5	13
Qu	20	8	27
Qt	0	0	1
<u>Cretaceous</u>			
Kbo	3	4	2
Kbu	3	25	69
Kdr	0	0	2
Ks	88	47	133
Ksf	1	2	1
Kft	5	1	11

(...) denotes negative anomaly

TABLE IV.11 Statistical Summary of Radioactivity Anomalies per Geologic Period(s)

Geologic Unit	^{208}Tℓ	^{214}Bi	^{214}Bi/^{208}Tℓ
<u>Quaternary</u>			
No. of units w/anomalies	2	2	3
No. of anomalies	25	13	41
<u>Cretaceous</u>			
No. of units w/anomalies	5	5	6
No. of anomalies	100	79	218
<u>Total Sample</u>			
No. of units w/anomalies	7	7	9
No. of anomalies	125	92	259

(...) denotes negative anomaly

Quaternary Geologic Units: Qal, Qu, Qt

^{208}Tℓ Anomalies

Twenty percent of the ^{208}Tℓ anomalies recorded in the Sonora map sheet area are reported from the units Qal and Qu. Over three-fourths (80%) of these anomalies are found in Qu. Quaternary exposures comprise roughly 15% of the total map area. The thorium ion is considered to be relatively insoluble, and it rarely concentrates in surface waters. The anomalies are presumably not economically significant.

^{214}Bi and ^{214}Bi/^{208}Tℓ Anomalies

Fourteen percent of the ^{214}Bi anomalies and sixteen percent of the ^{214}Bi/^{208}Tℓ anomalies are recorded over the Quaternary units. Of these anomalous types, over one-half (61% and 66%, respectively) are from the unit Qu. There are three points of geographic coincidence within Qu: ML20, stations 1546-1561, and ML60, stations 1053 and 1353-1373.

Where these anomalies do not coincide, they are thought to be a product of intraformational changes in lithology (see Table IV.8).

Cretaceous Geologic Units: Kbo, Kbu, Kdr, Ks, Ksf, Kft

^{208}Tℓ Anomalies

Eighty percent of the ^{208}Tℓ anomalies are recorded over the Cretaceous units, with the exception of the unit Kdr. Of these, over three-fourths (88%) are found in the unit Ks. Cretaceous-aged units are exposed over approximately 85% of the survey area.

^{214}Bi and ^{214}Bi/^{208}Tℓ Anomalies

Eighty-six percent of the ^{214}Bi anomalies and eighty-four percent of the ratio anomalies are present in the Cretaceous units. Over one-half of these anomalies (59% and 61%, respectively) are reported from Ks. There are 42 geographic locations where ^{214}Bi and ^{214}Bi/^{208}Tℓ anomalies coincide with one another: ML20, stations 1241-1251 (Ks), and 1266-1271, 1386-1391 and 2021 (Kbu); ML40, stations 6924-6929 and 7149 (Kbu), 7104-7109 (Kbo), and 7234, 7254-7274 and 7299-7314 (Ks); ML60, stations 1068-1078, 1098 and 1178-1208 (Ks), and 1253-1258 and 1503 (Kbu); ML80, stations 6468, 7423-7438 and 7468-7473 (Ks), and 7223-7233 (Kbu); ML100, stations 1021-1031, 1071-1076 and 1146-1171 (Ks), and 1241-1246 (Kbu); ML120, stations 7113, 7158 and 7168-7178 (Ks); ML140, stations 1178-1193 and 1843-

1848 (Kbu); ML180, stations 71-76, 131, 6839-6844 and 6854-6864 (Kbu); TL5140, stations 2929-2934 (Ks); TL5180, stations 1178-1183 (Kbu); and TL5200, stations 4242-4252, 4272-4282, 4292-4302, 4317-4327, 4337-4342, 4362-4372, 4392-4412 and 4452-4512 (Ks).

These loci of coincidence may reflect epigenetic uranium mineralizations in the units Ks and Kbu.

<u>Relationship between Radioactivity Anomalies and Cultural Features</u>

The cultural features in the Sonora map sheet area which may influence radioactivity data are few. They include the towns of Sonora, Rocksprings, Eldorado, Ozona and Iraan. There are no man-made reservoirs in the map region, although the San Saba, South Llano, Dry Devils, Devils and Pecos rivers, as well as many small, intermittent lakes may have affected the results of the survey to a certain extent.

There are no ^{208}Tℓ, ^{214}Bi and ^{214}Bi/^{208}Tℓ anomalies associated directly with towns. A number of ^{214}Bi and ratio anomalies are located in the proximity of the Pecos River; however, allowing for the accuracy of the survey, these anomalies are considered to be associated with land.

<u>Relationship between Radioactivity Anomalies and Known Radioactive Mineral Deposits</u>

There are no reported radioactive mineral deposits directly within the Sonora map sheet area.

<u>Trends</u>

^{208}Tℓ Anomalies

^{208}Tℓ anomalies are virtually absent from the southwestern quarter and the extreme western edge of the map area. They are relatively scarce in the southeastern corner of the map. With these exceptions, the ^{208}Tℓ anomalies are generally evenly distributed throughout the region.

^{214}Bi Anomalies

The ^{214}Bi anomalies are concentrated exclusively west of the Pecos River, in the southwestern corner of the map. They may be associated with the underlying structure of the Marathon Folded Belt.

The ^{214}Bi anomalies are concentrated exclusively west of the Pecos River, in the southwestern corner of the map. They may be associated with the underlying structure of the Marathon Folded Belt.

^{214}Bi/^{208}Tℓ Anomalies

The distribution pattern for ratio anomalies in the Sonora map sheet generally mirrors that of the ^{214}Bi anomalies. It is slightly more extensive, however.

3. Summary and Recommendations

The ^{208}Tℓ, ^{214}Bi and ^{214}Bi/^{208}Tℓ anomalies in the Sonora map sheet region are recorded predominantly over Cretaceous-aged exposures. To a much lesser extent, the anomalies are reported from the Quaternary units in the map sheet area.

The ^{214}Bi and ratio anomalies show approximately the same distribution pattern in the southwestern quarter of the map. There are many coincident loci of the two anomalous types within the Cretaceous units Ks and Kbo in this general area. Where these units are carbonaceous or contain asphaltite, they may provide significant concentrations of epigenetic uranium.

F. NATIONAL GAMMA RAY MAP SERIES (NGRMS)

The geologic base has been photographically screened to allow emphasis of the flight line locations and of the information regarding data analysis. These maps are used as the base for presenting statistical information on the six variables:

* ^{208}Tℓ
* ^{214}Bi
* ^{40}K
* ^{214}Bi/^{208}Tℓ Ratio
* ^{214}Bi/^{40}K Ratio
* ^{208}Tℓ/^{40}K Ratio

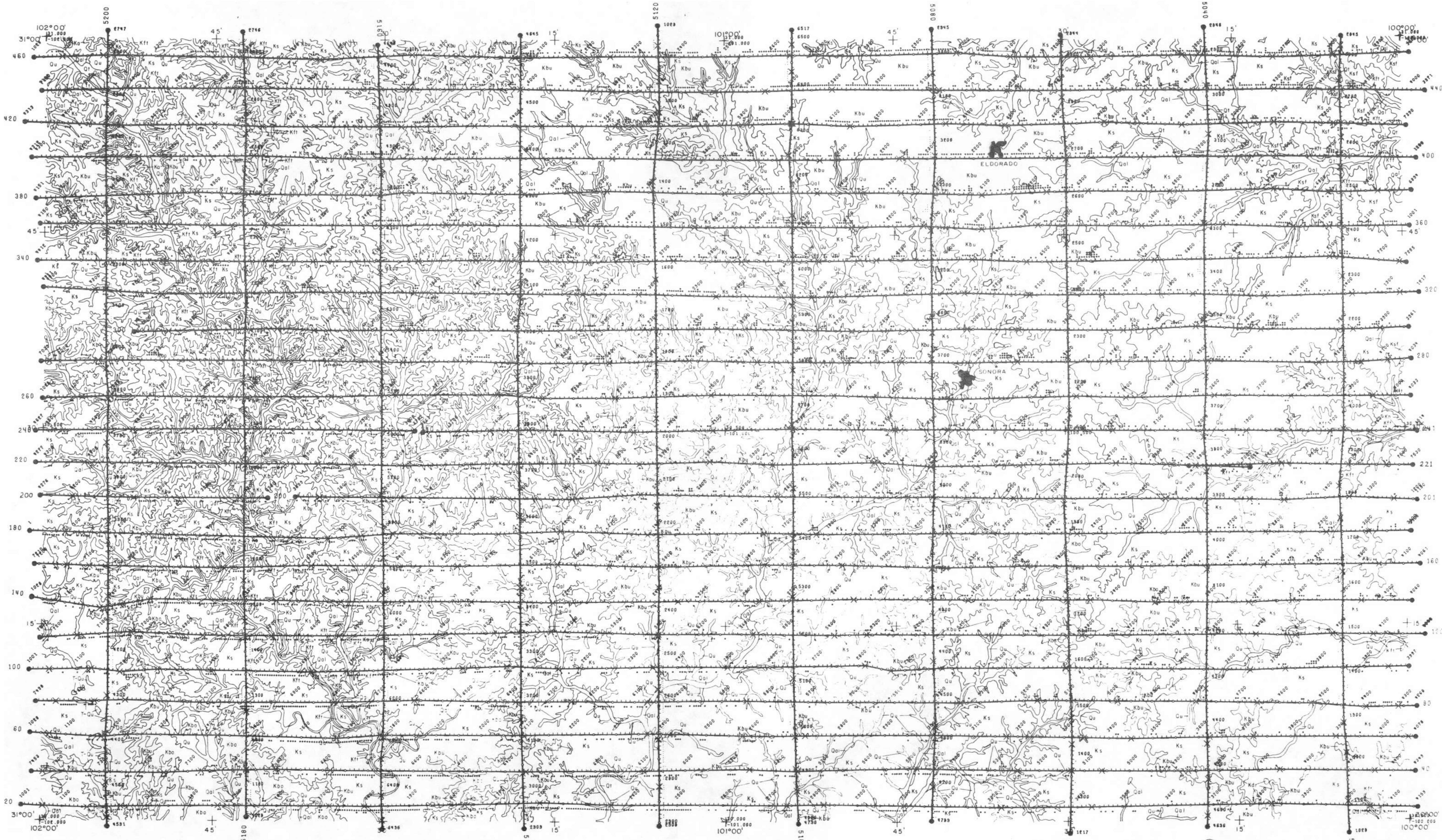
The six NGRMS sheets are presented in Figures IV. (1-6) of this report at a scale of 1:500,000 and as separate sheets at a scale of 1:250,000.

The statistical information is summarized on these maps through the utilization of one, two or three dots above or below the flight line at every fifth data point. One dot above the line indicates that the variable value at that point is between 1σ and 2σ greater than the mean value for that geologic type where σ values are determined for each geologic type based on all flight line data from the area, as is discussed further in Section V.B.4. Two dots indicate values between 2σ and 3σ, and three dots show values

greater than 3σ. Dots below the line indicate the variable values which are less than the mean value by 1, 2 or 3σ in the same manner.

G. LINE PRINTER CONTOURS

Printer contours have been generated at a 1:500,000 scale for seven variables (eTh, eU, K, eU/eTh, eU/K, eTh/K, and RMag, respectively). They appear in Appendix IV. Note that every alternate contour interval is composed of blanks to help delineate contour boundaries. Dots are used where the denominator value for a ratio is approaching zero, and to denote non-data areas.



GEODATA INTERNATIONAL, INC.

NATIONAL GAMMA RAY MAP SERIES

Sonora, Texas

Tl = STANDARD DEVIATIONS

REF. NTMS, NH 14-4

PREPARED FOR
U.S. DEPARTMENT OF ENERGY

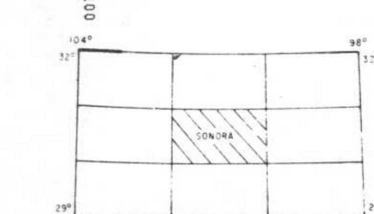
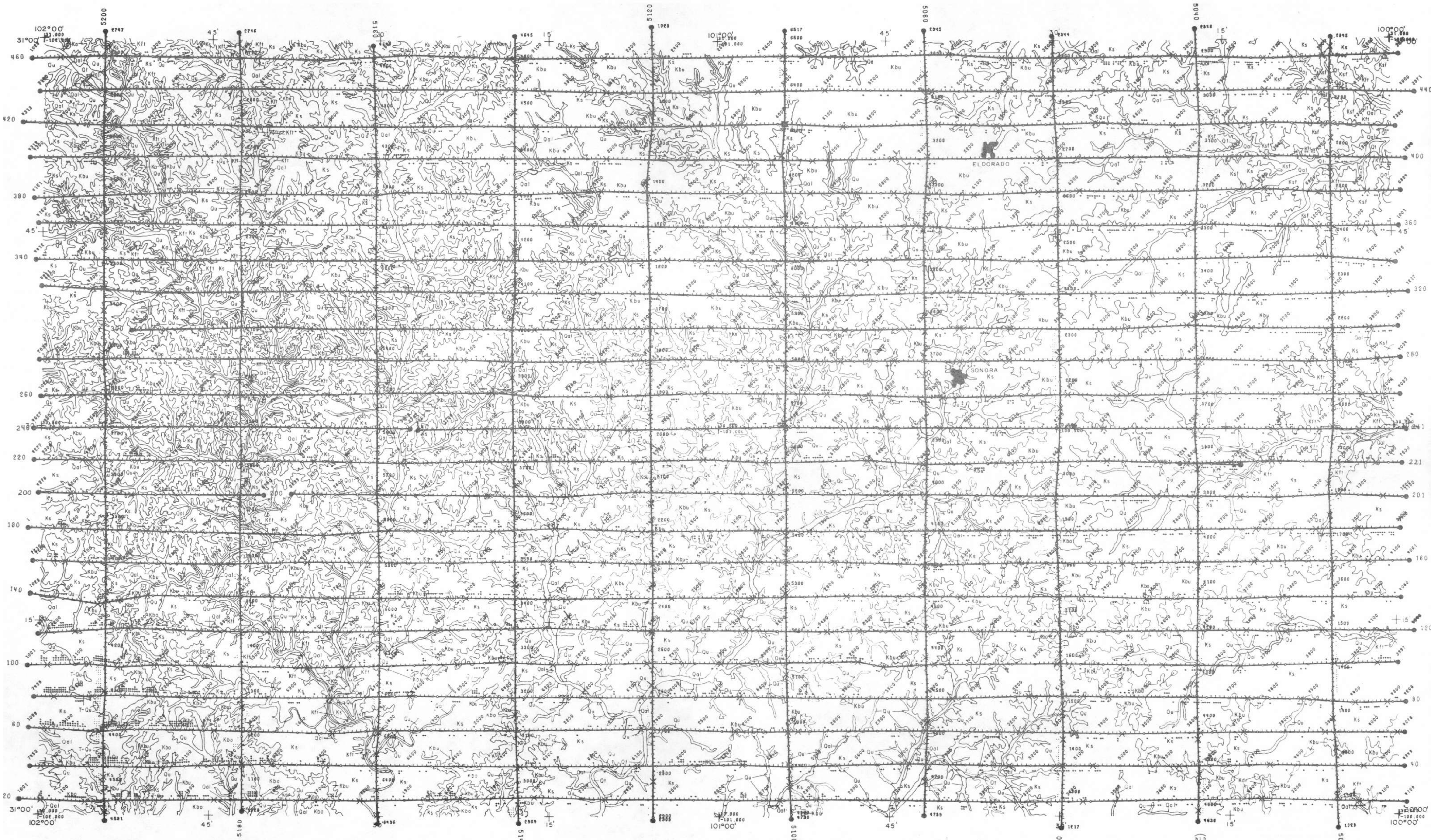


Figure IV.1 National Gamma Ray Map Series



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NATIONAL GAMMA RAY MAP SERIES

Sonora, Texas

^{214}Bi : STANDARD DEVIATIONS

REF. NTMS, NH 14-4
PREPARED FOR
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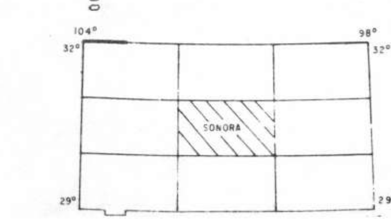
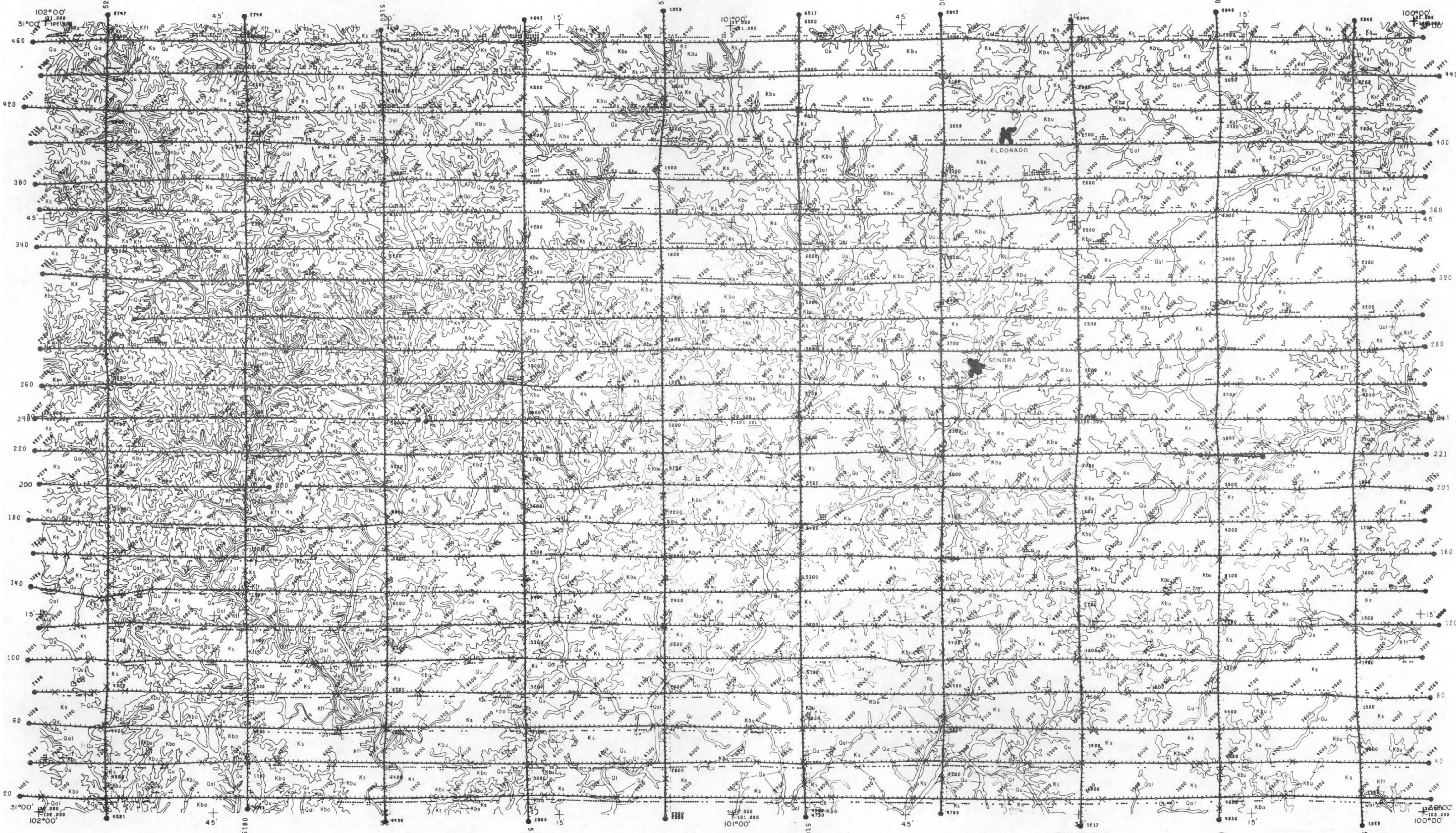


Figure IV.2 National Gamma Ray Map Series



GEODATA INTERNATIONAL, INC.

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NATIONAL GAMMA RAY MAP SERIES

Sonora, Texas

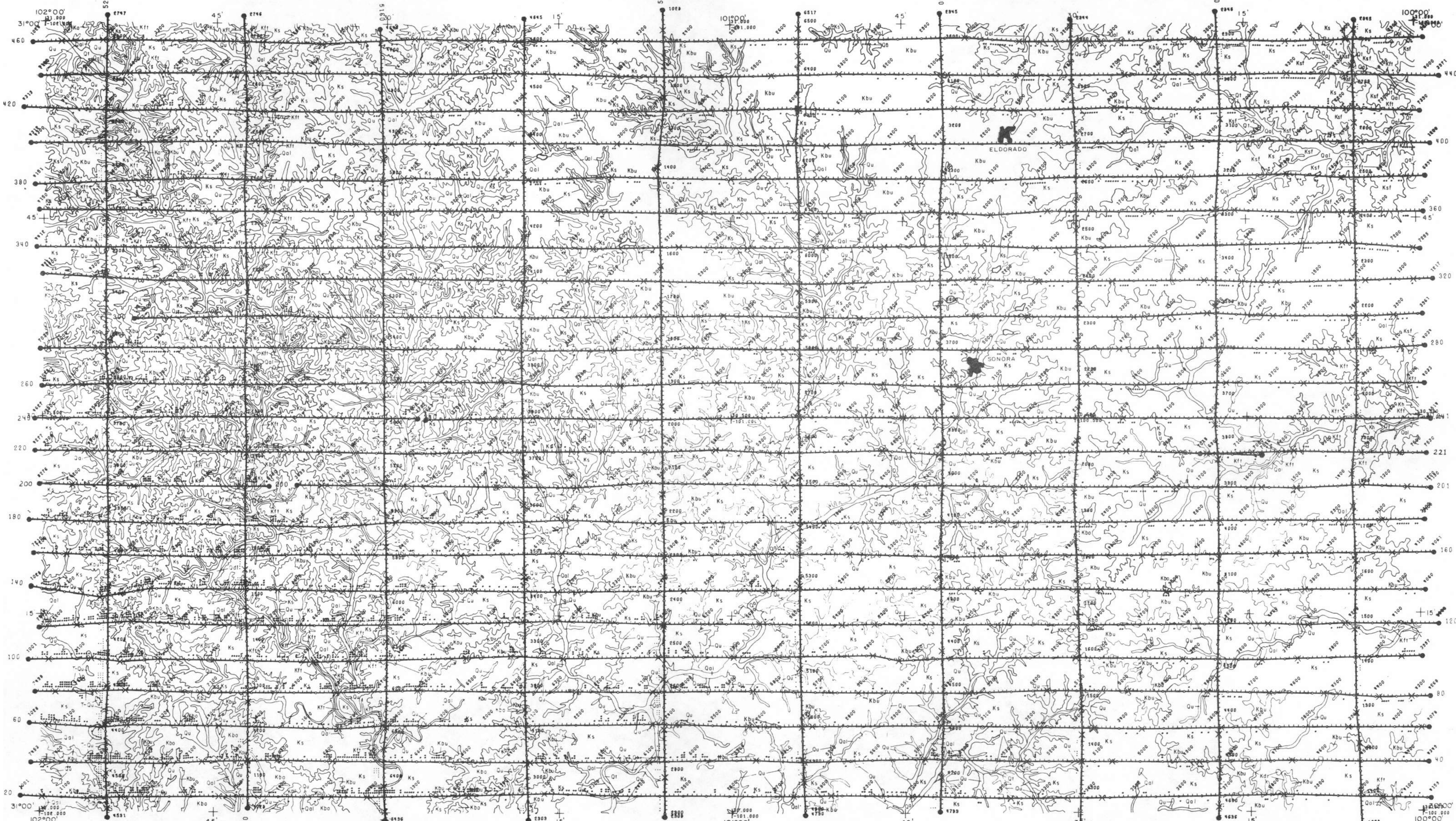
K=STANDARD DEVIATIONS

REF NTMS, NH 14-4

PREPARED FOR

U.S. DEPARTMENT OF ENERGY

Figure IV.3 National Gamma Ray Map Series



GEODATA INTERNATIONAL, INC.

NATIONAL GAMMA RAY MAP SERIES

Sonora, Texas

$^{214}Bi/^{208}Tl$ STANDARD DEVIATIONS

REF. NTMS, NH 14-4

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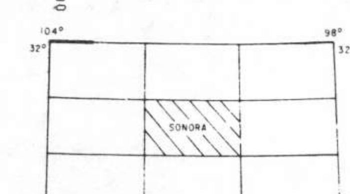
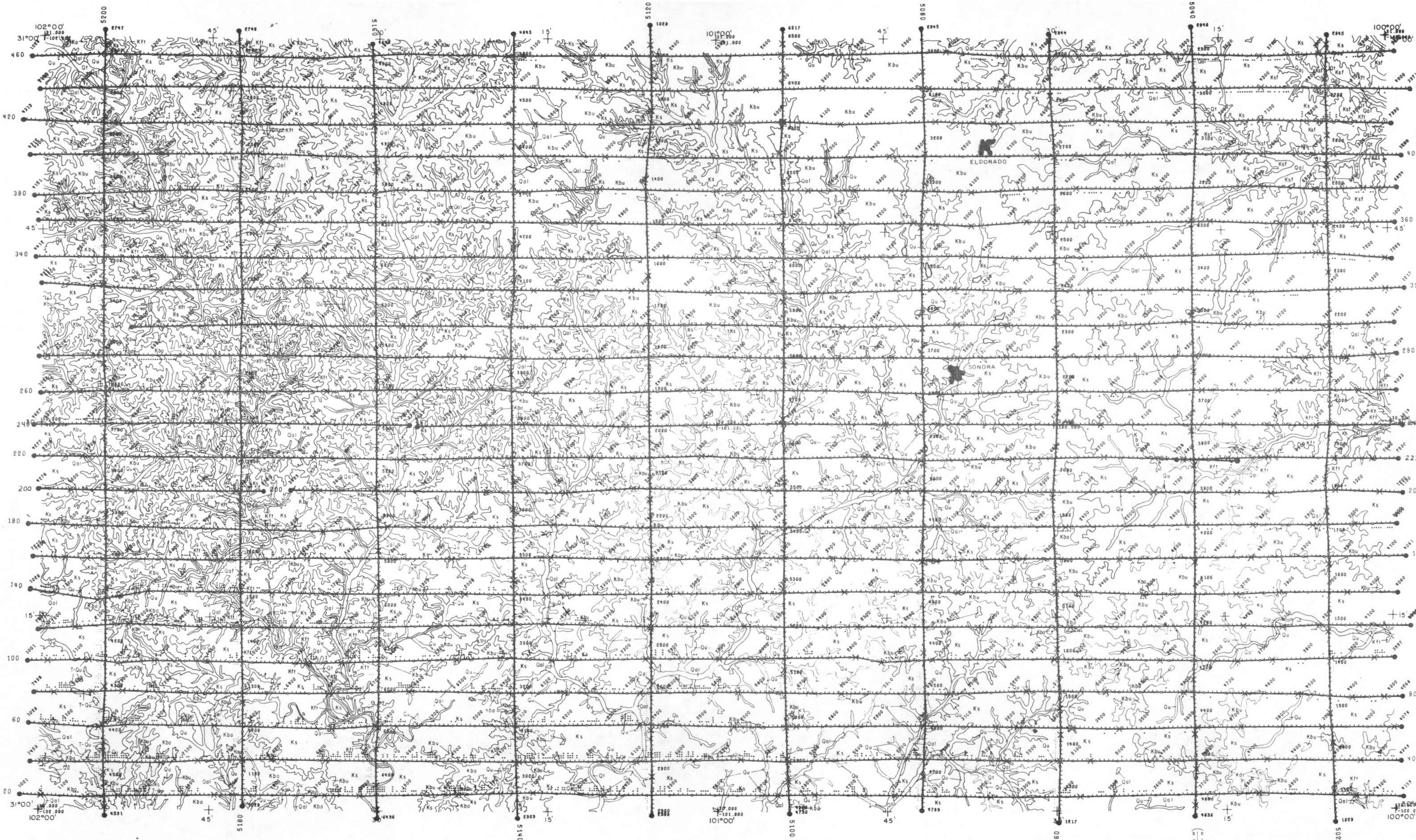


Figure IV.4 National Gamma Ray Map Series



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NATIONAL GAMMA RAY MAP SERIES

Sonora, Texas

$^{214}Bi/^{40}K$: STANDARD DEVIATIONS

REF. NTMS, NH 14-4
PREPARED FOR
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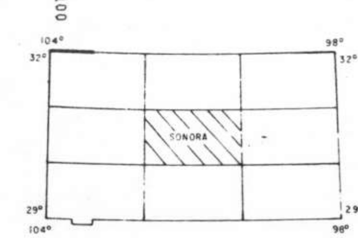
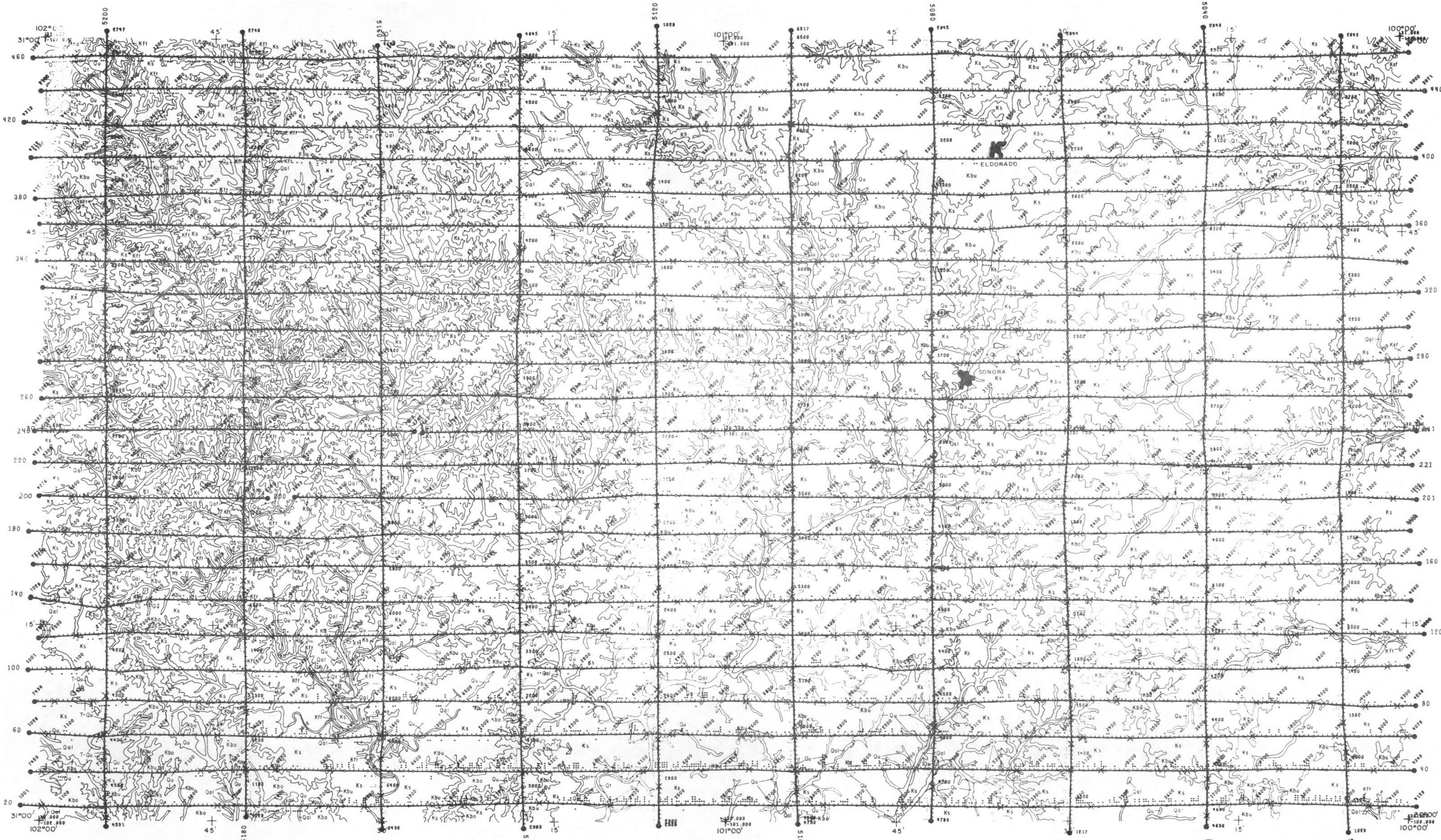


Figure IV.5 National Gamma Ray Map Series



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NATIONAL GAMMA RAY MAP SERIES

Sonora, Texas

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REF. NTMS, NH 14-4

PREPARED FOR
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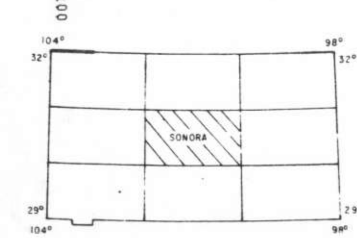
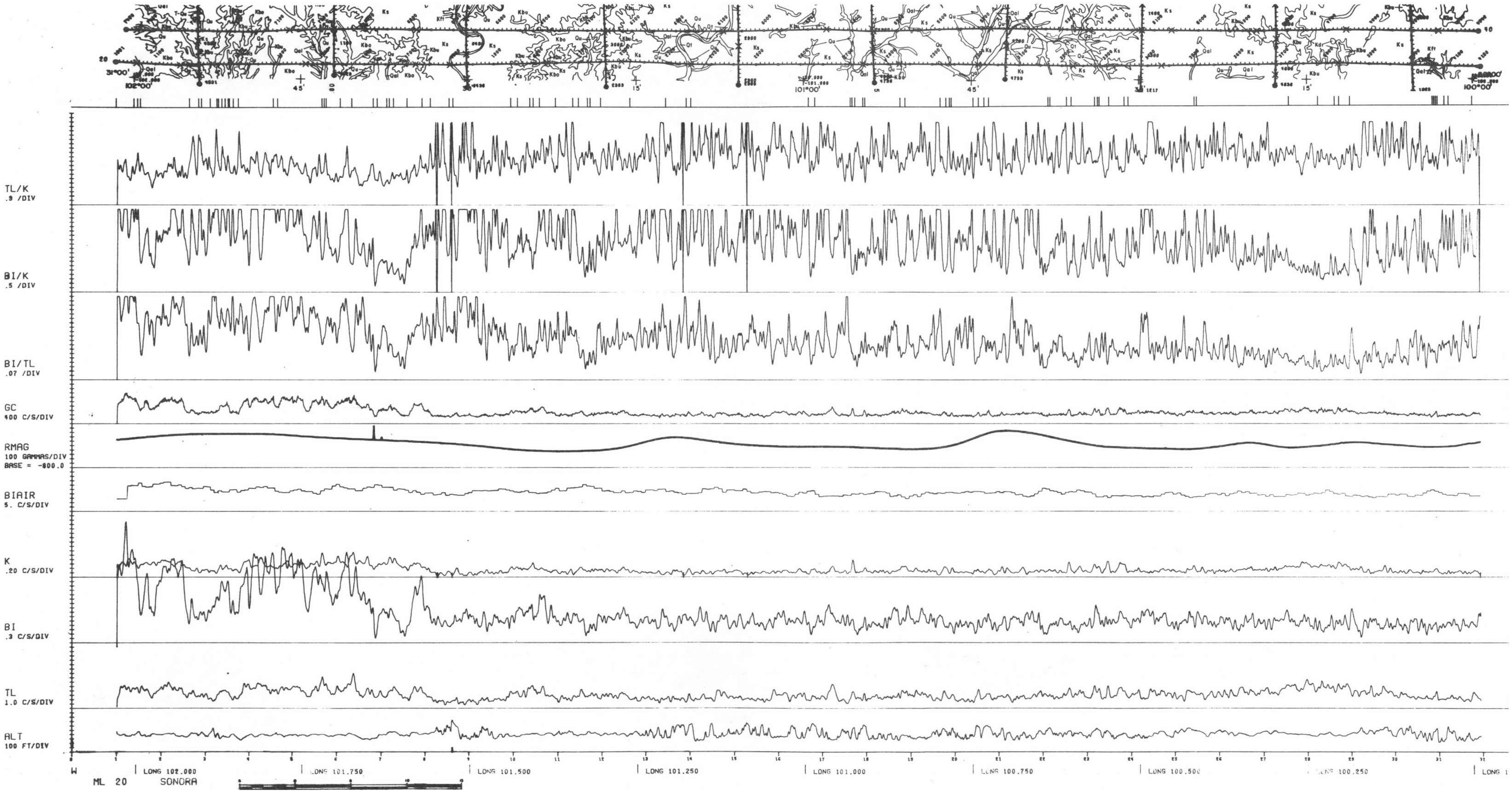


Figure IV.6 National Gamma Ray Map Series

H. STACKED DATA PROFILES AND GEOLOGIC HISTOGRAMS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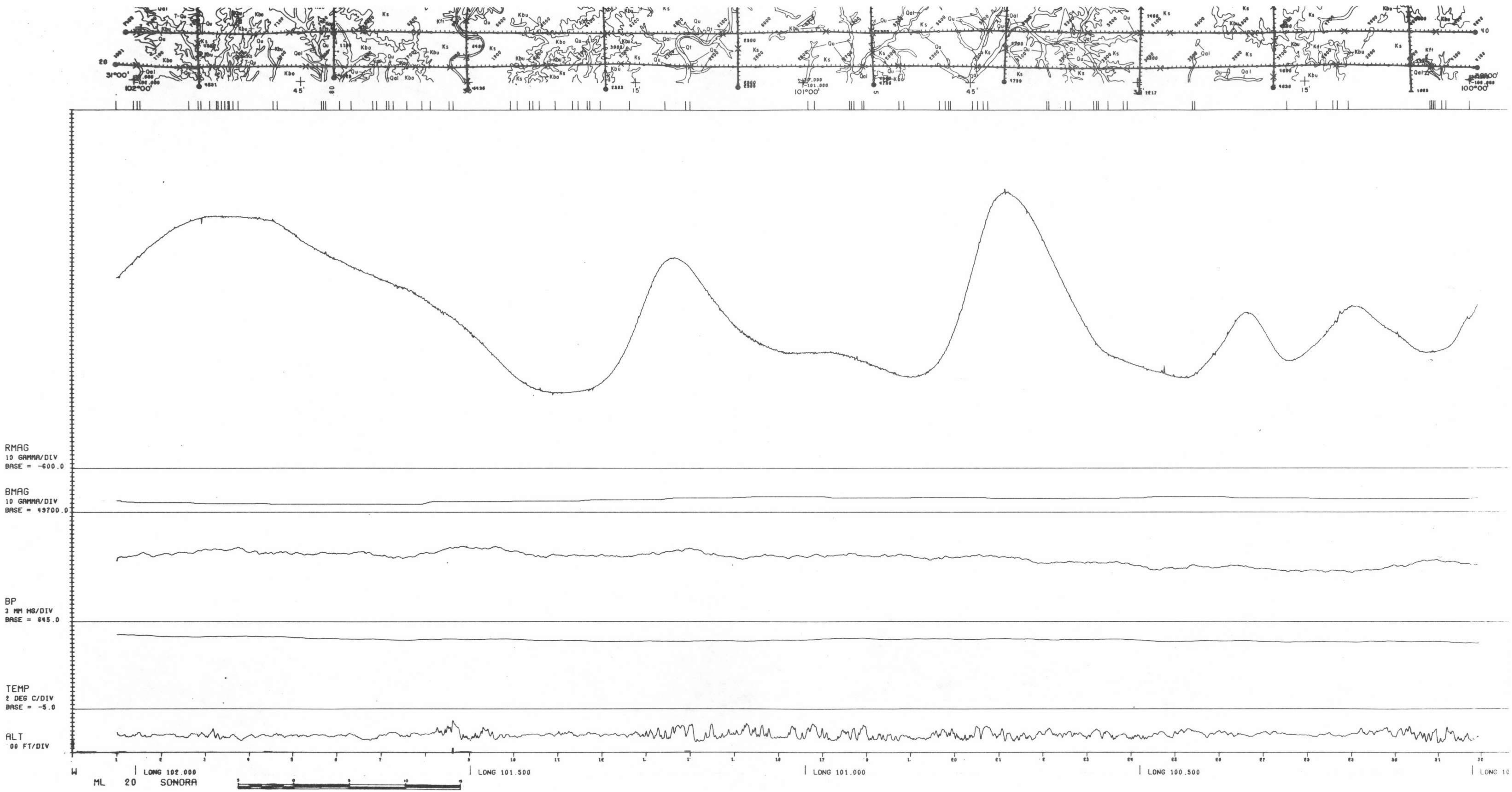
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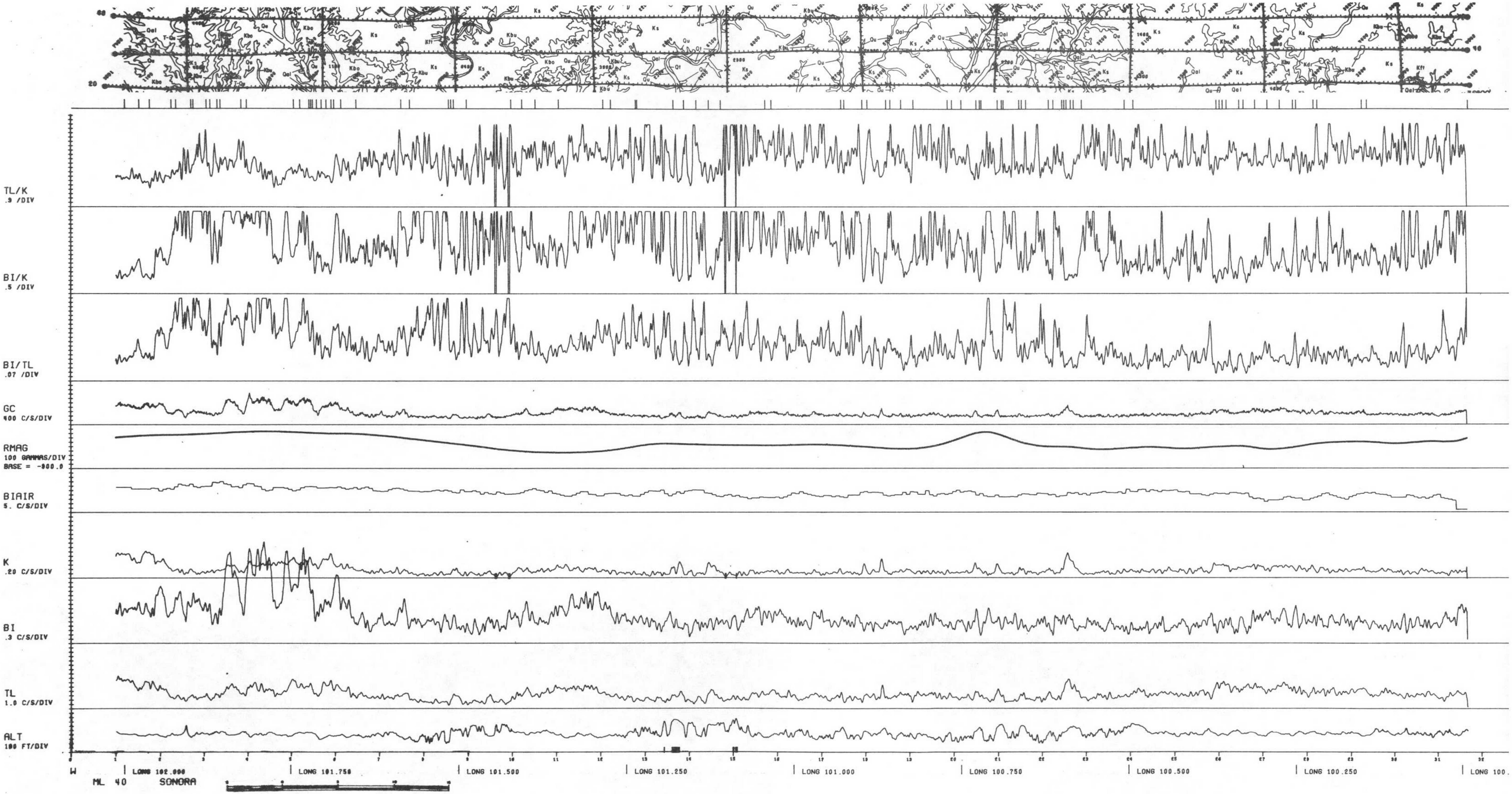
ML 20 SONORA



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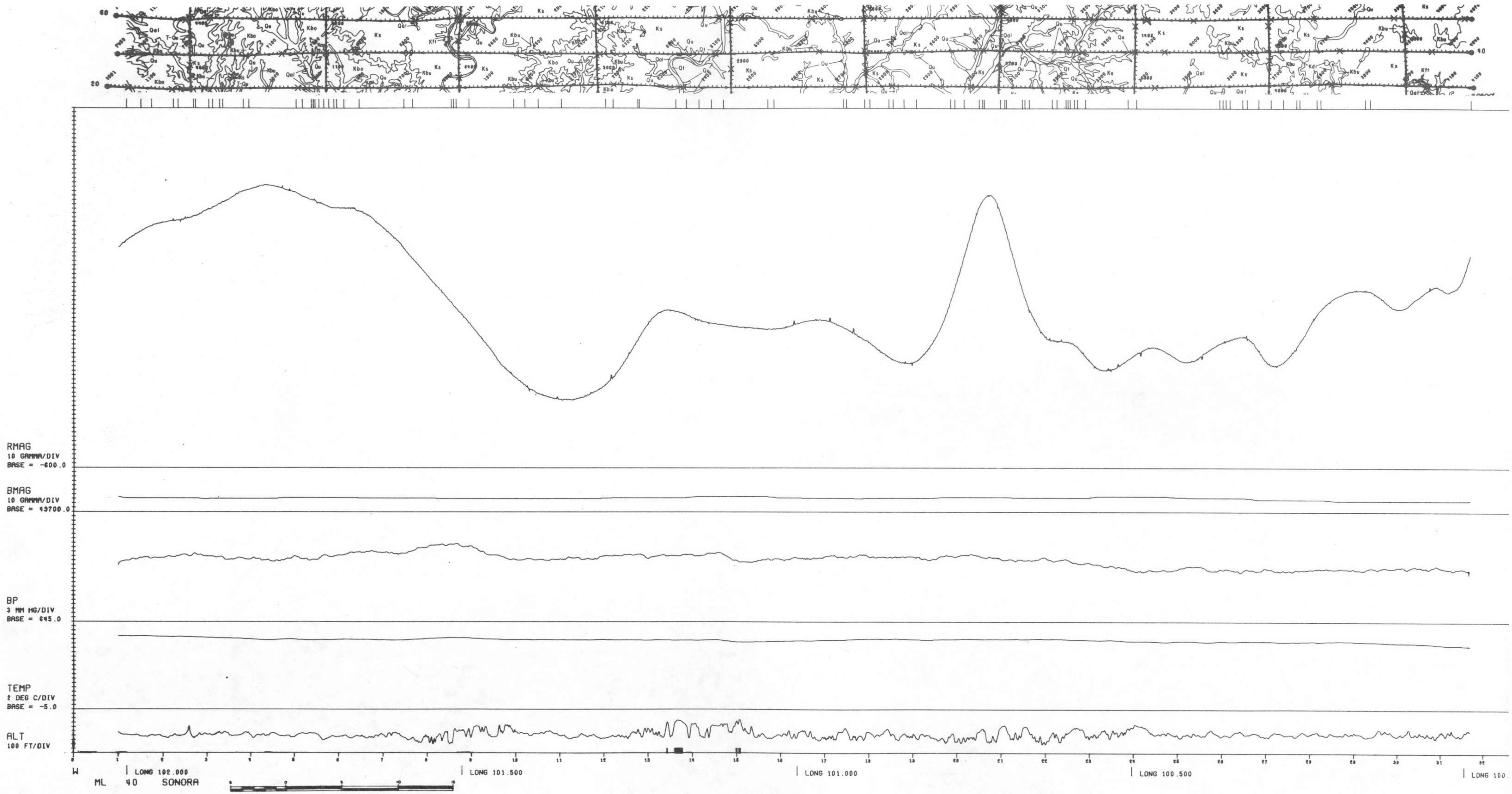
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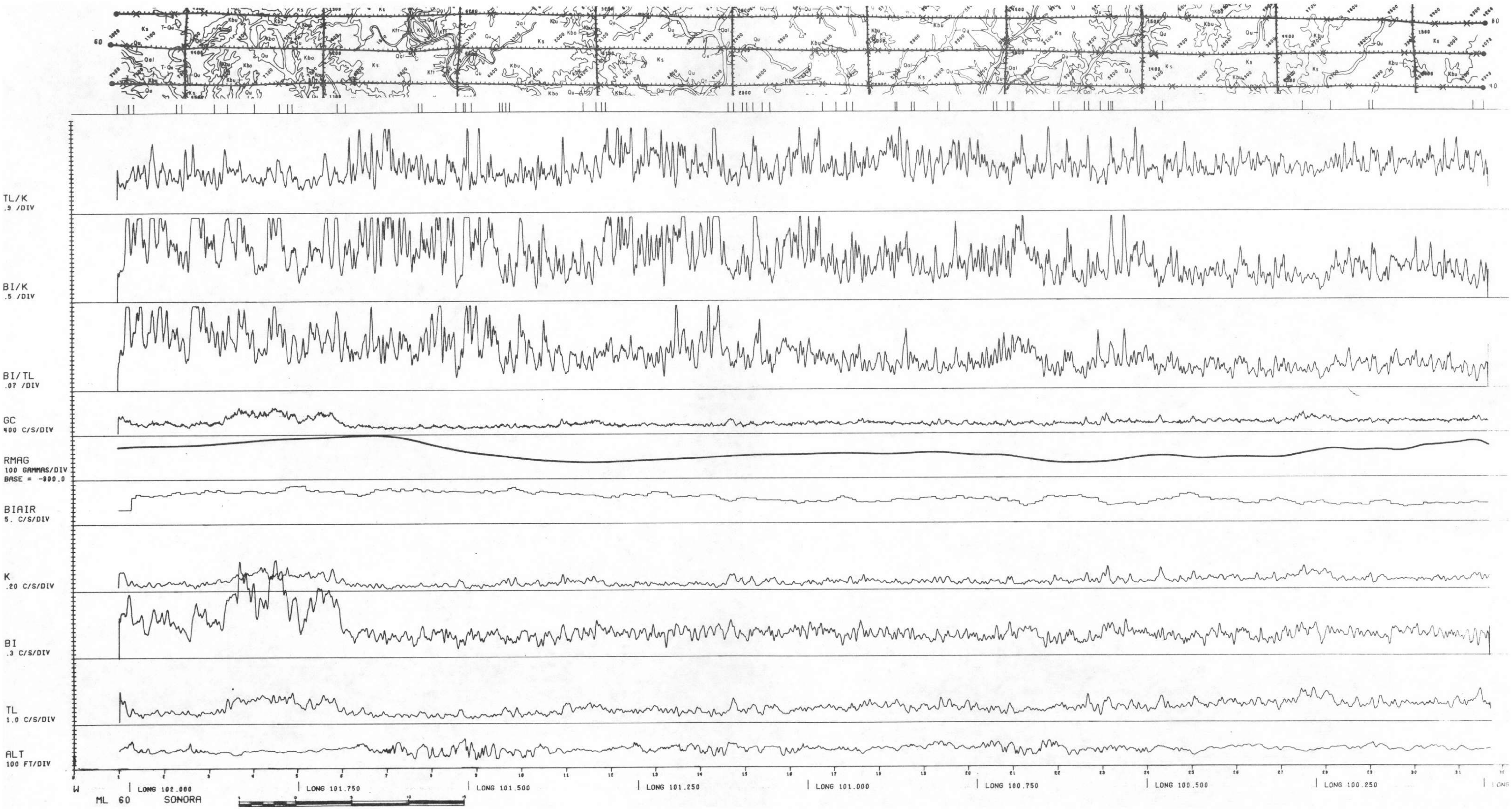

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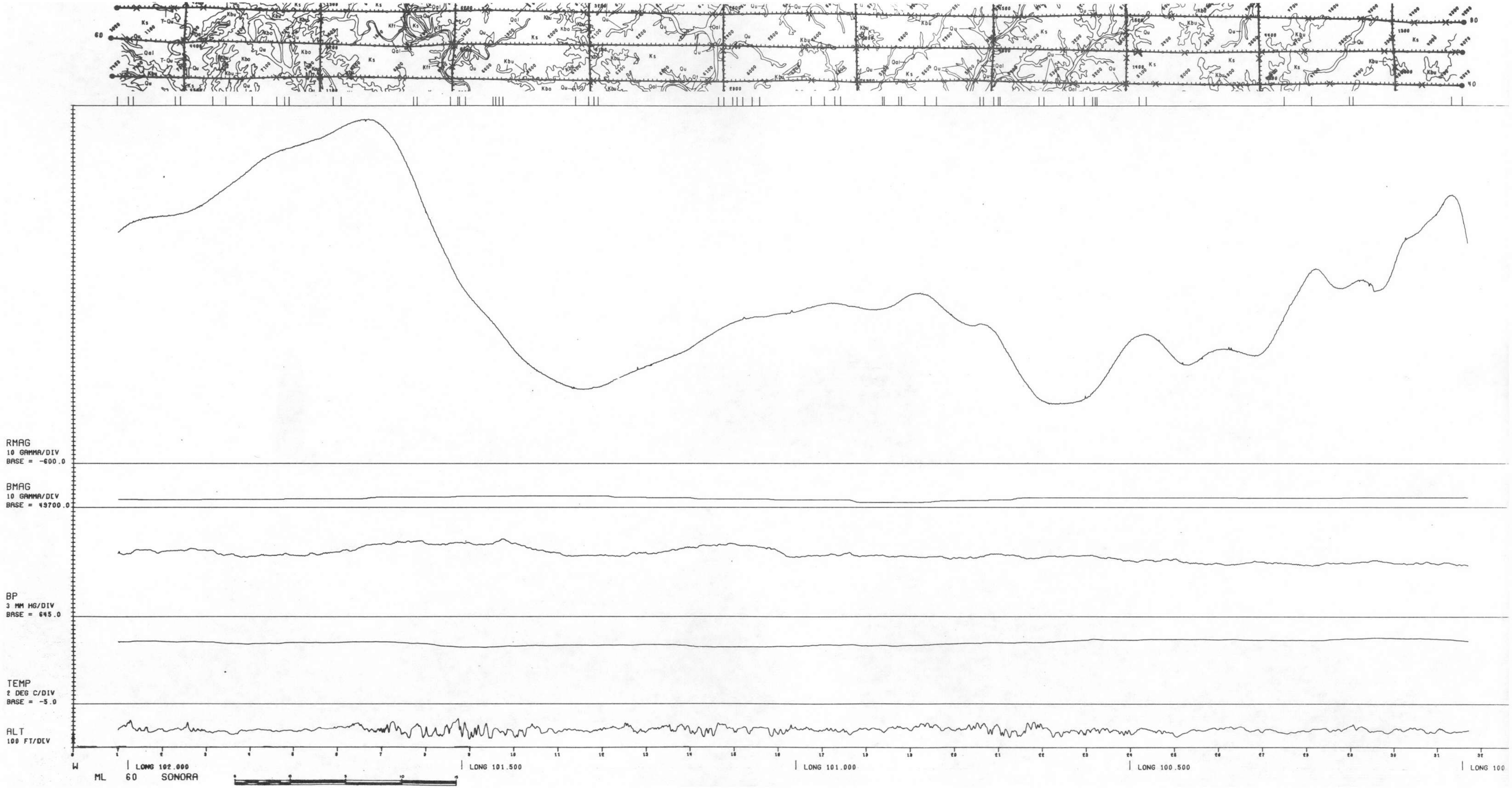
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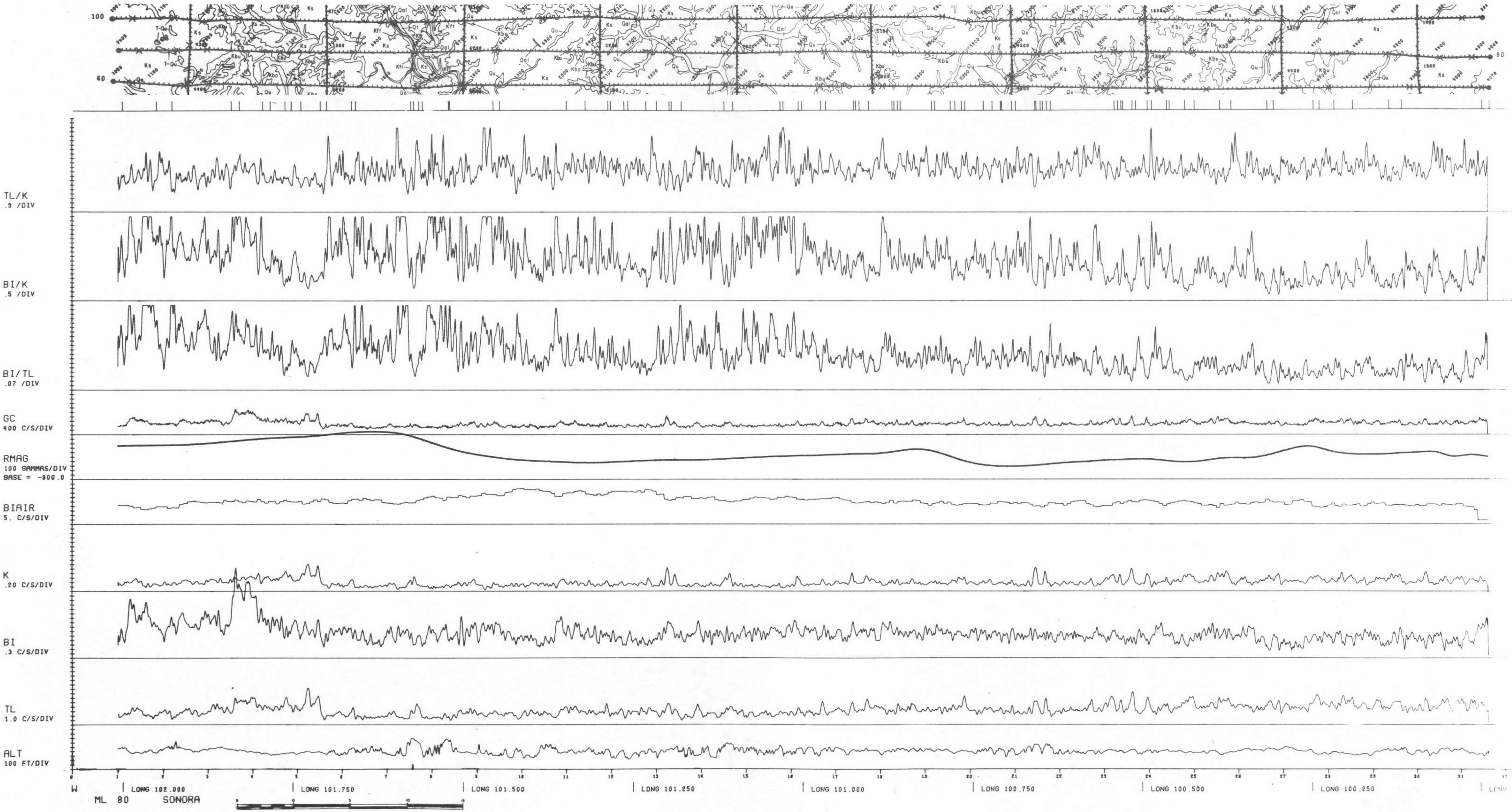
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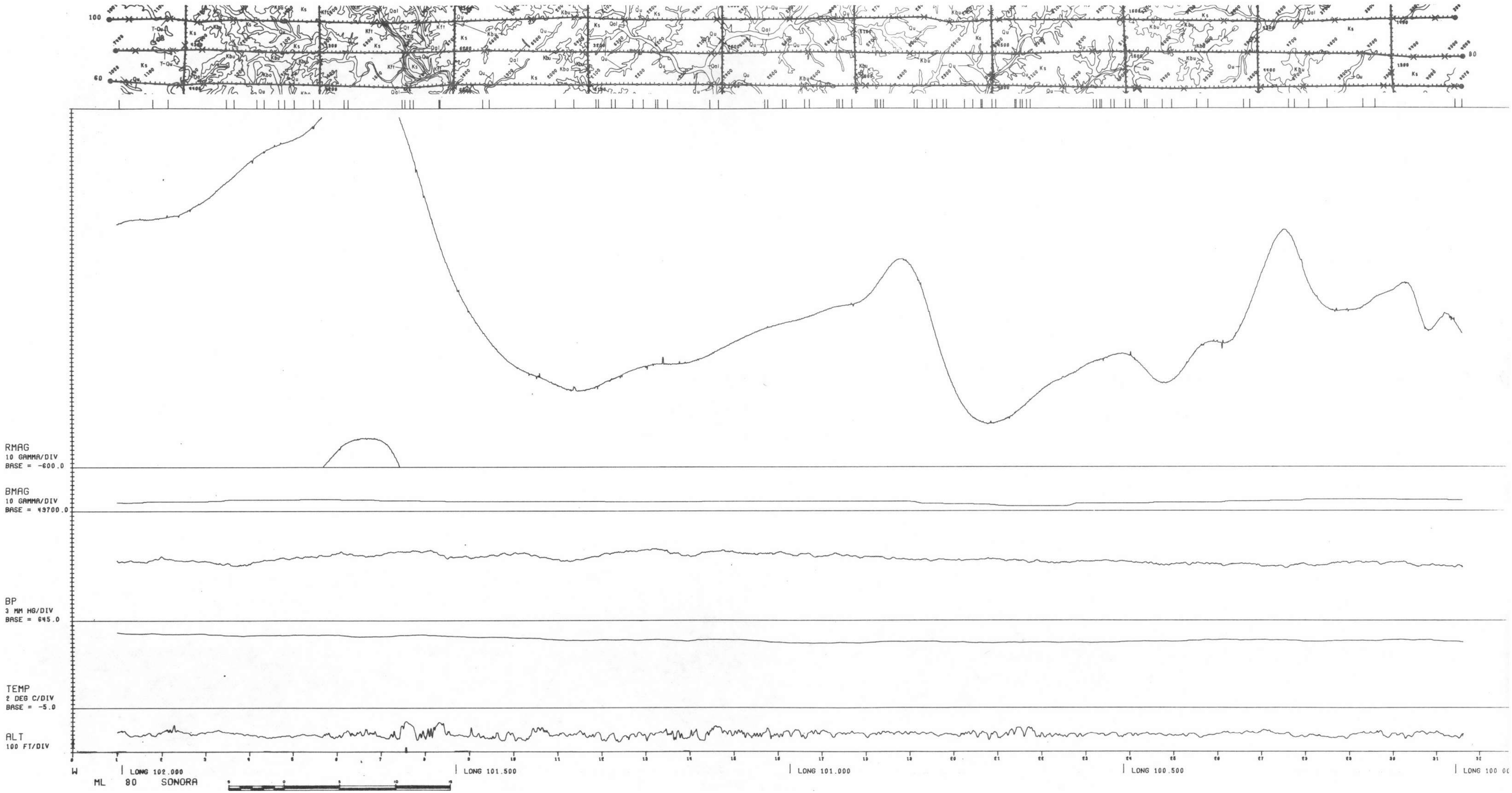
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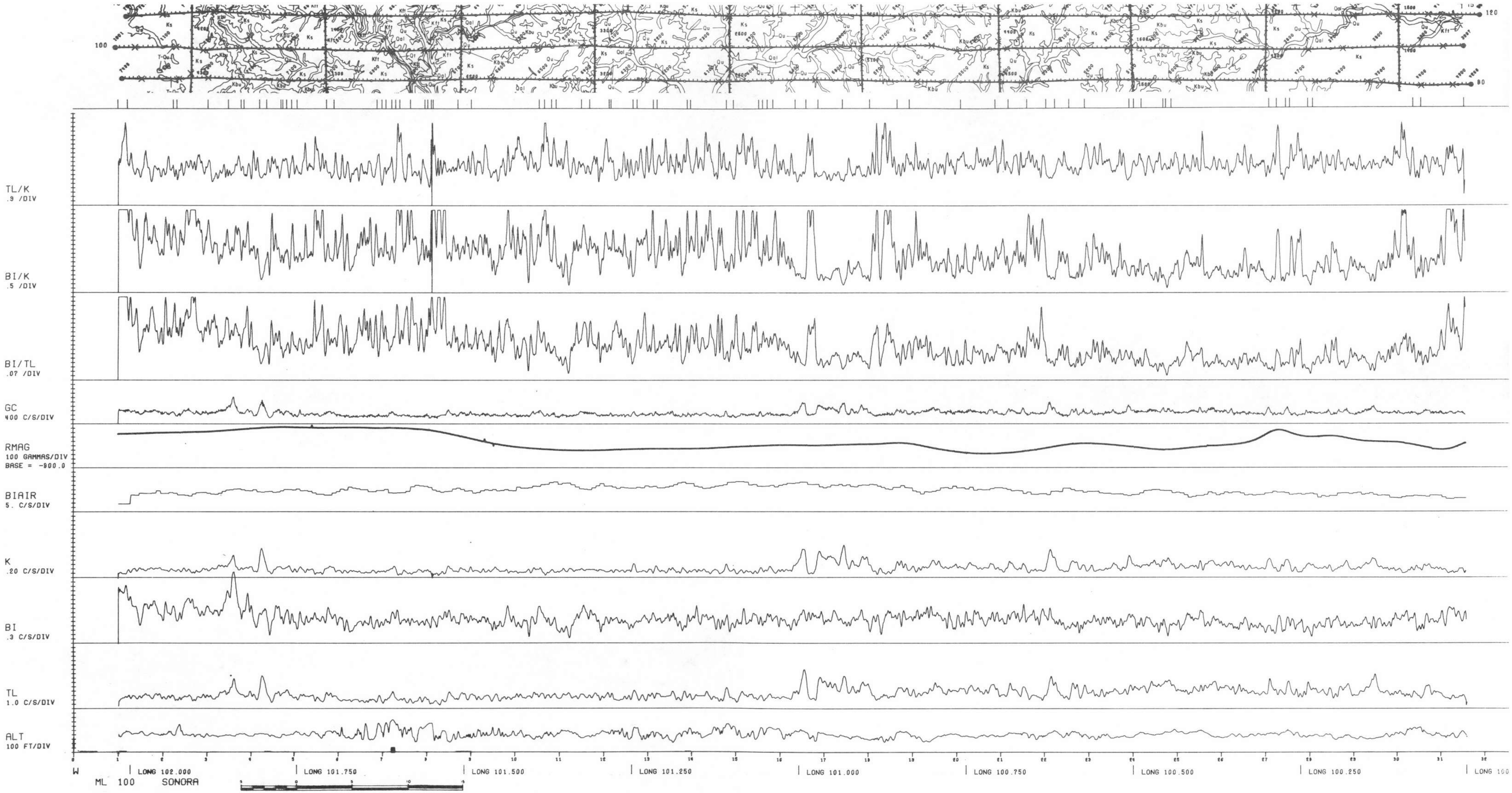
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BI
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TL
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ALT
100 FT/DIV
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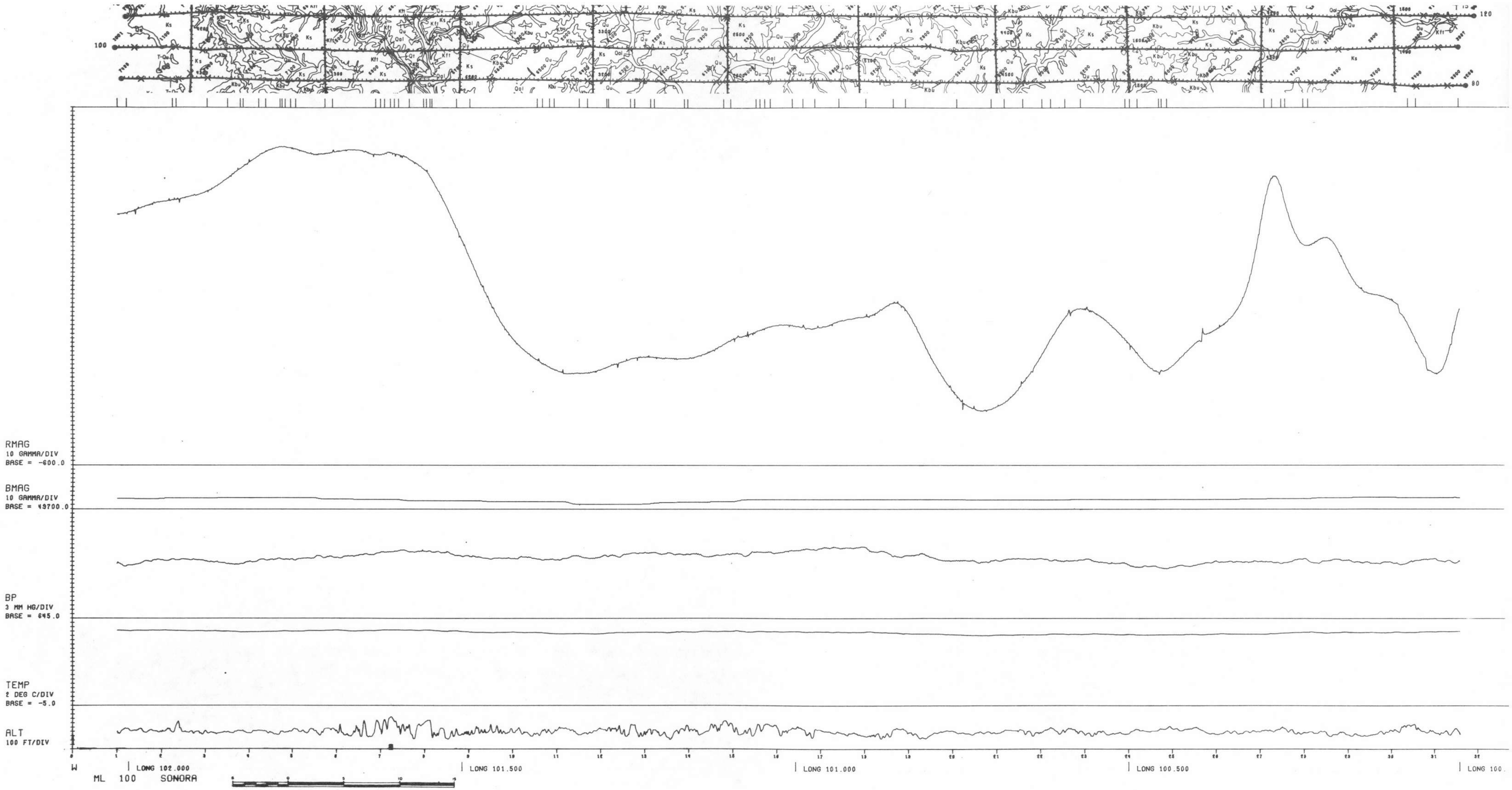
ML 100 SONORA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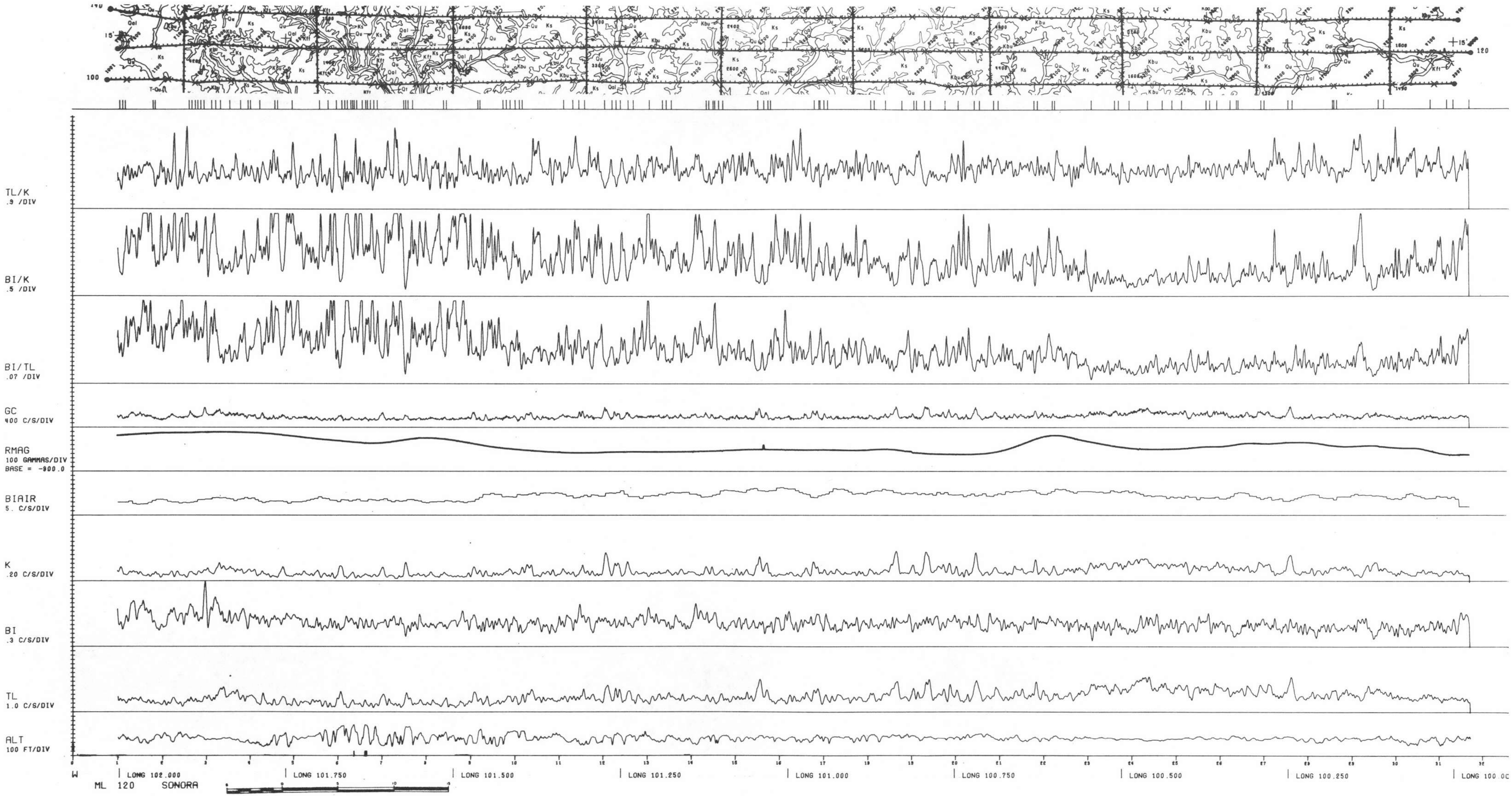
LONG 100.
ML 100 SONORA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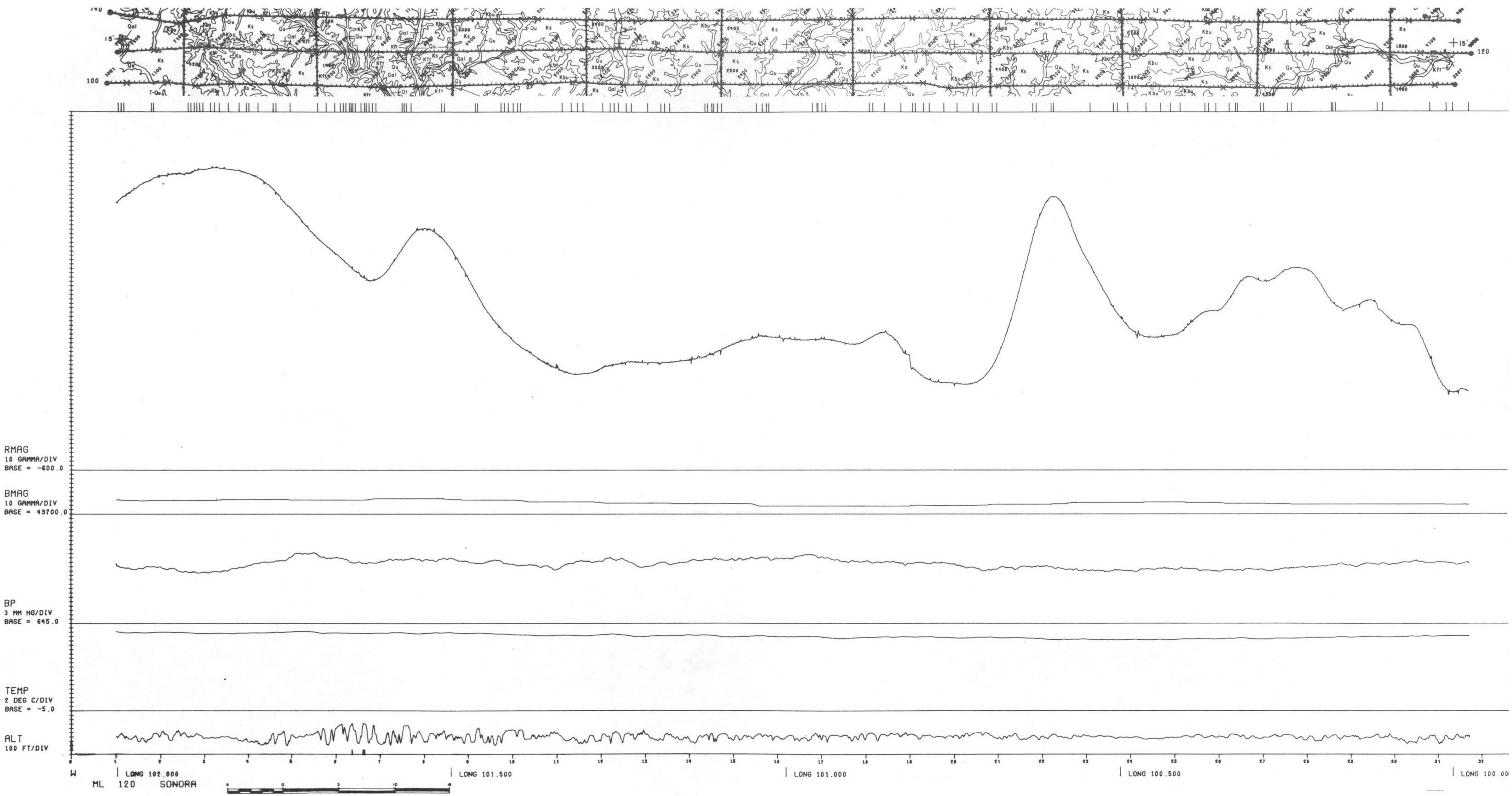
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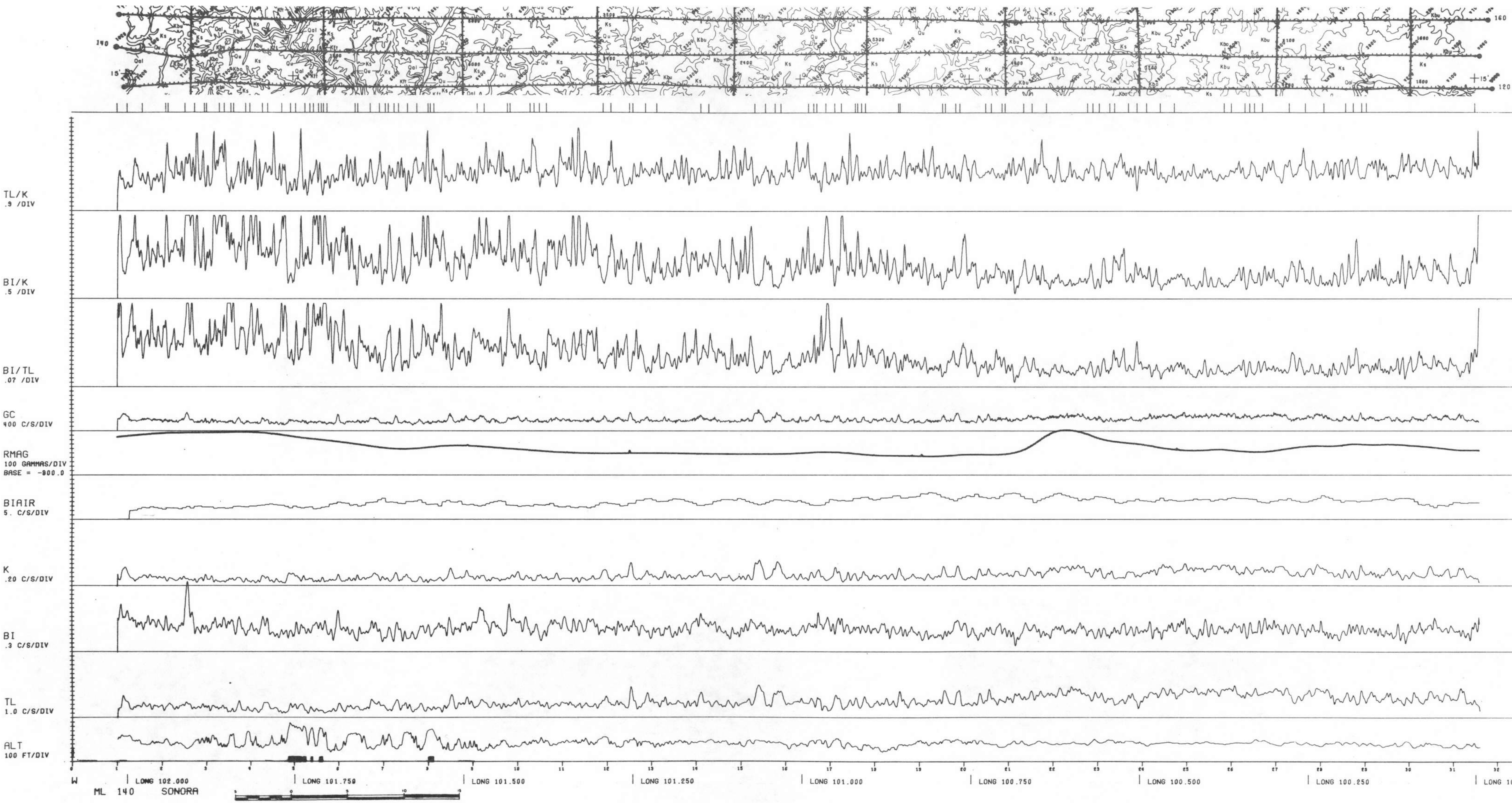
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BI
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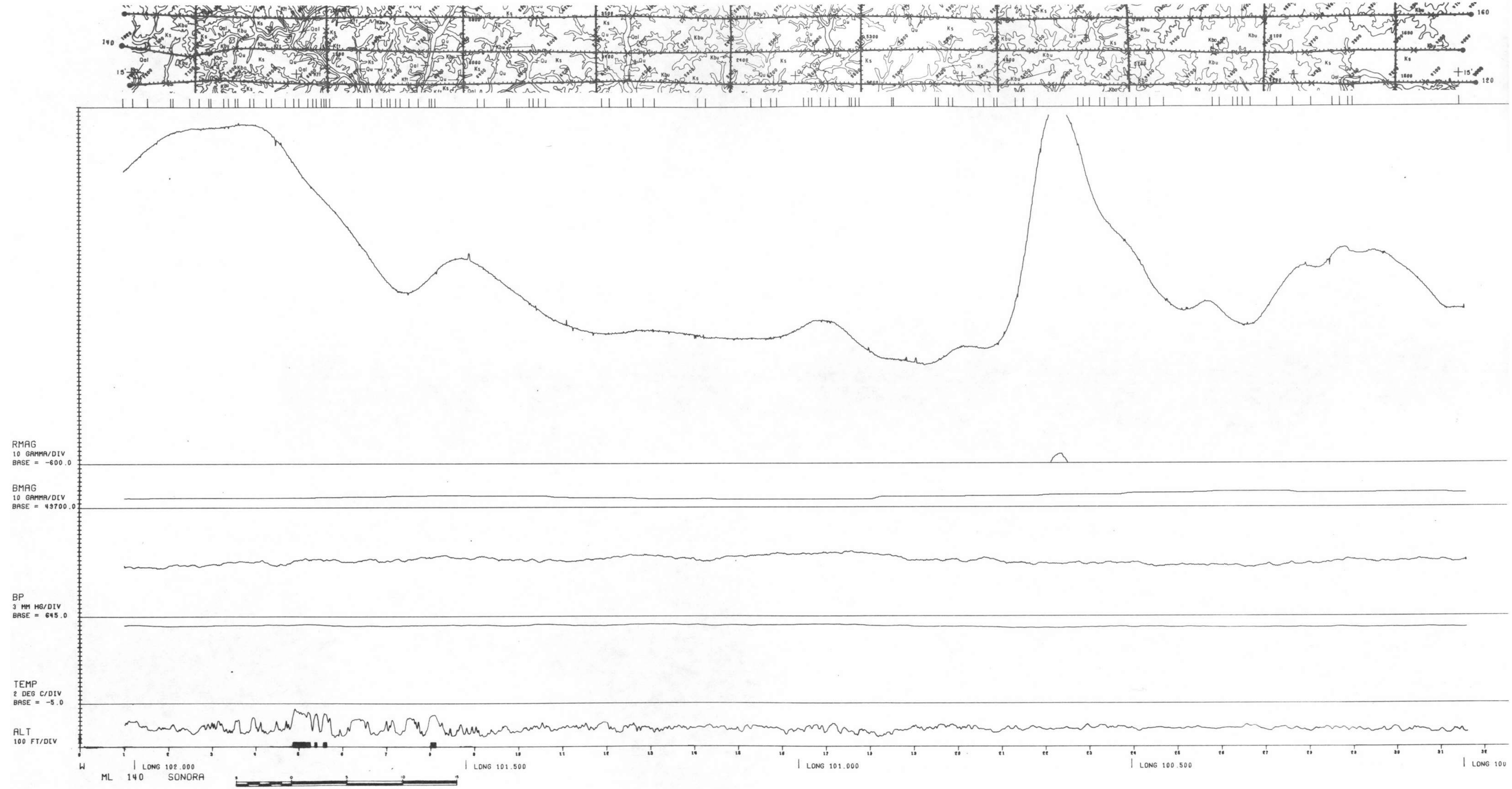

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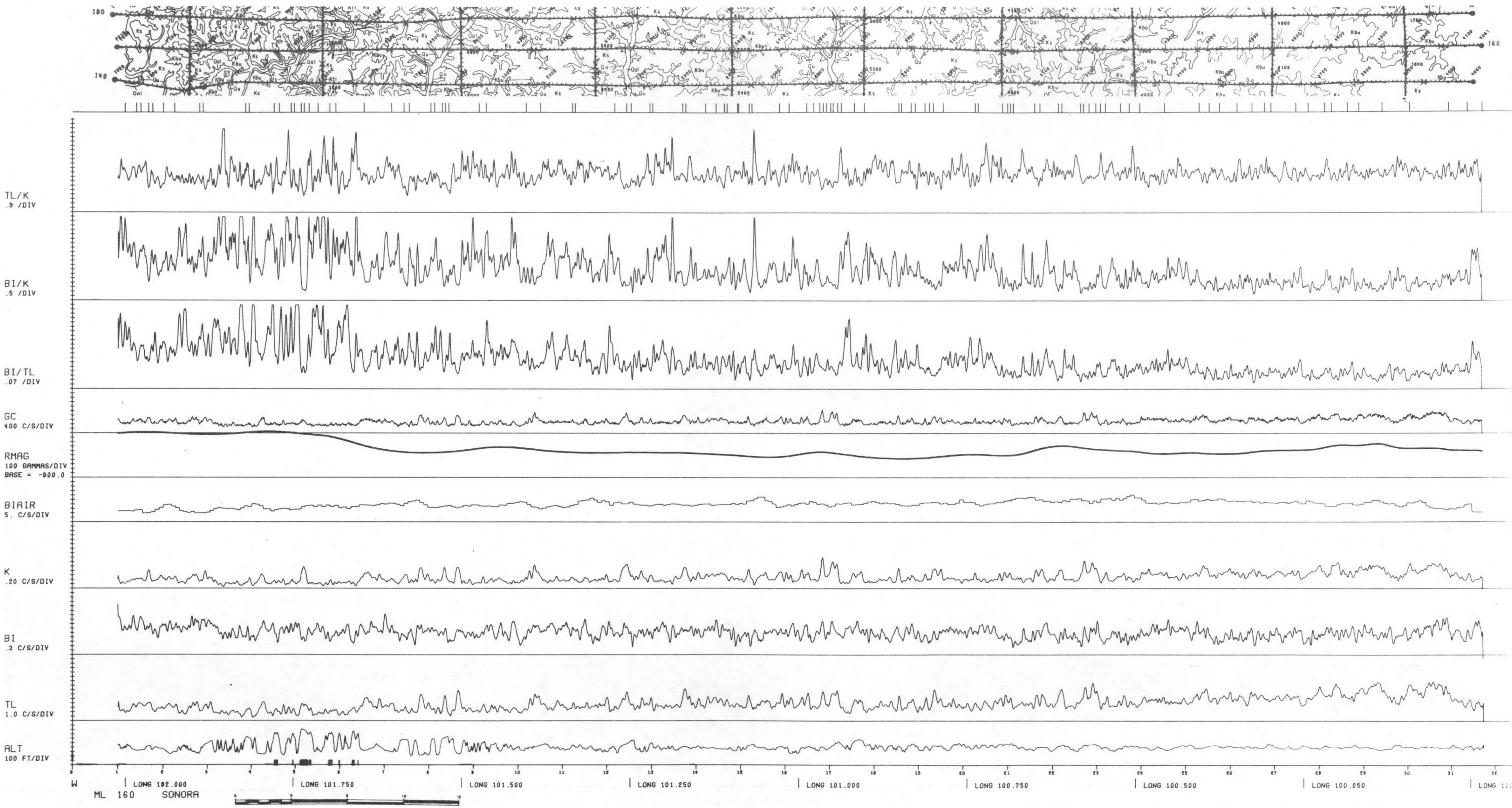
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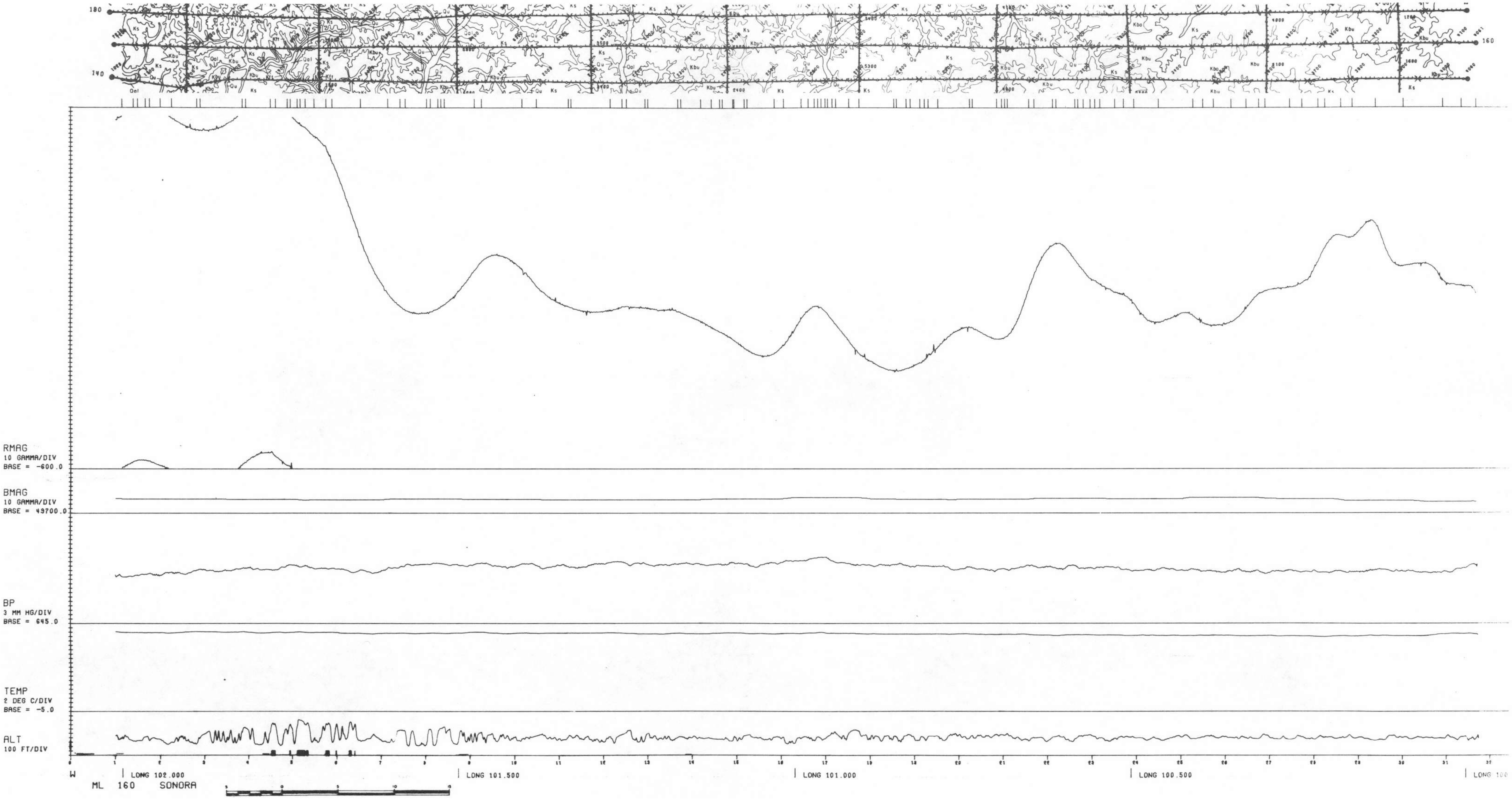

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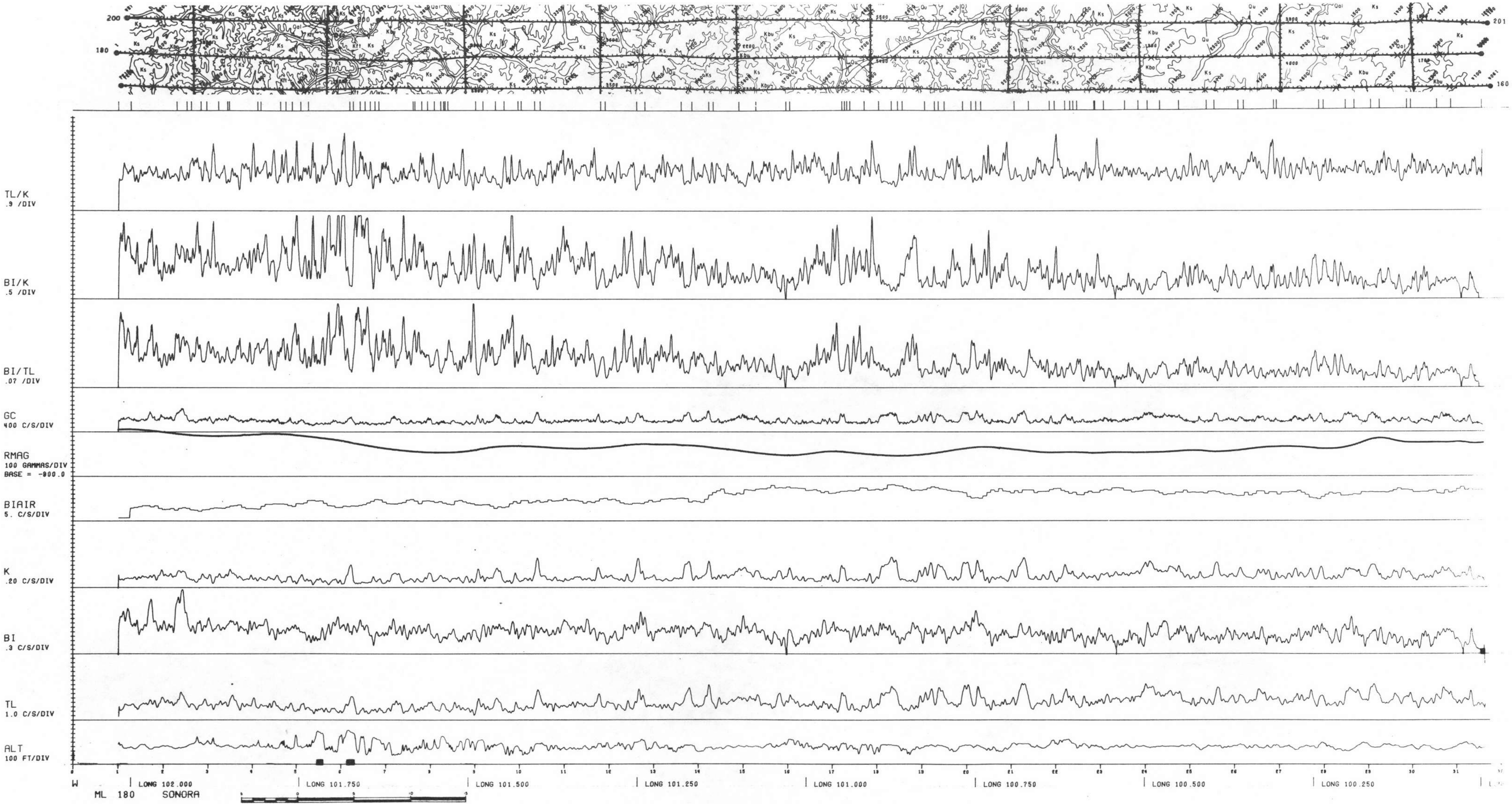

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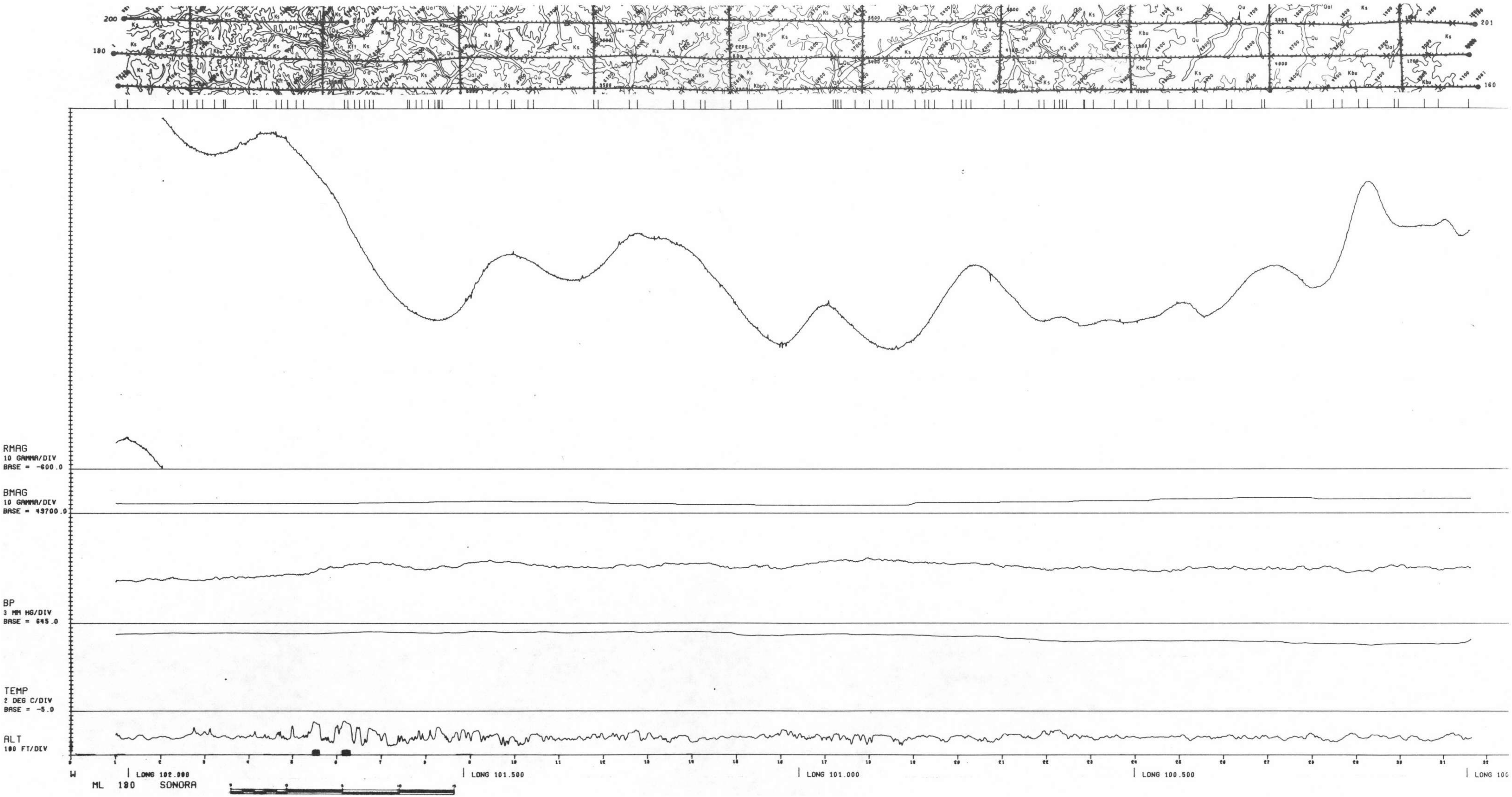
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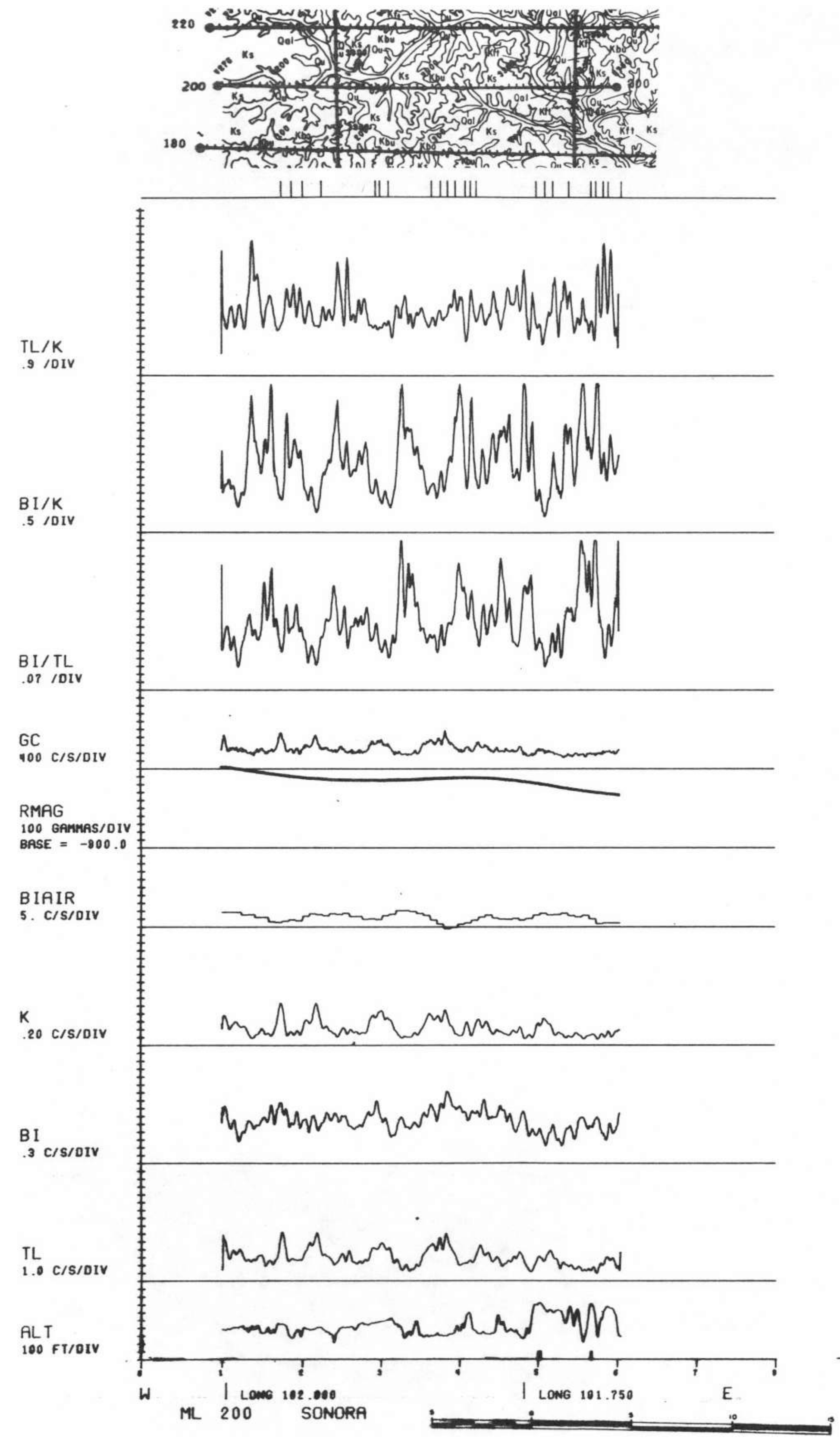
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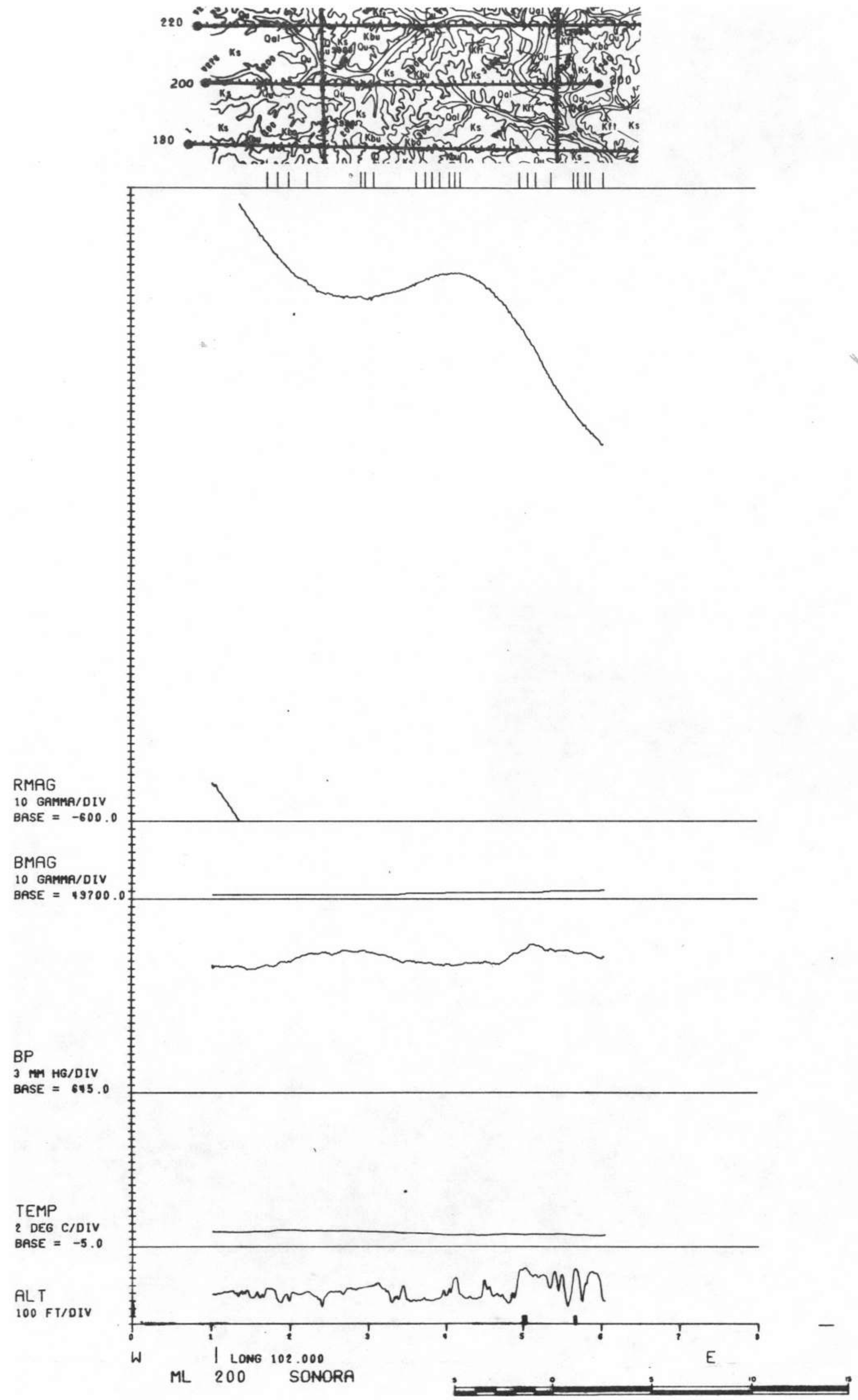

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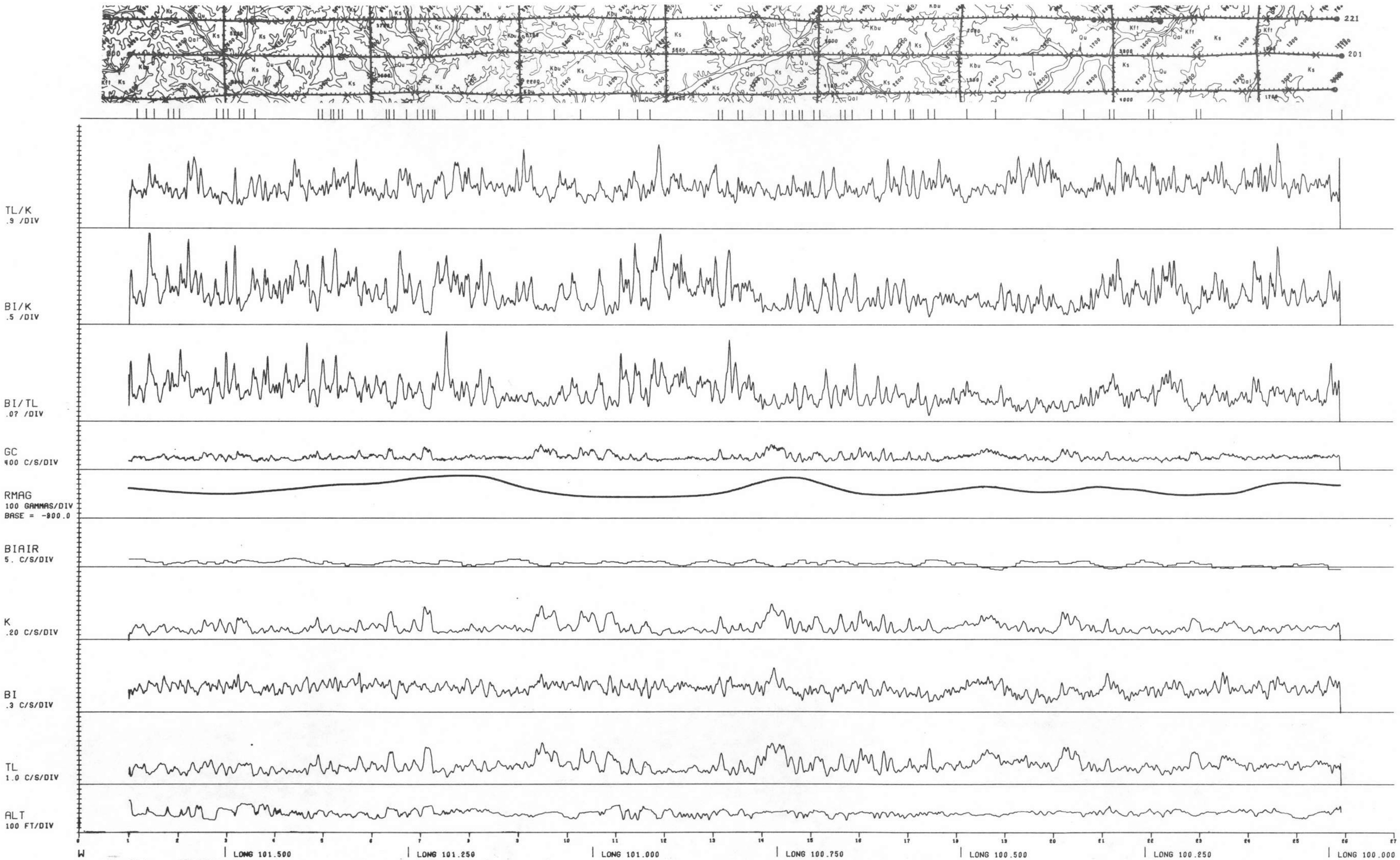

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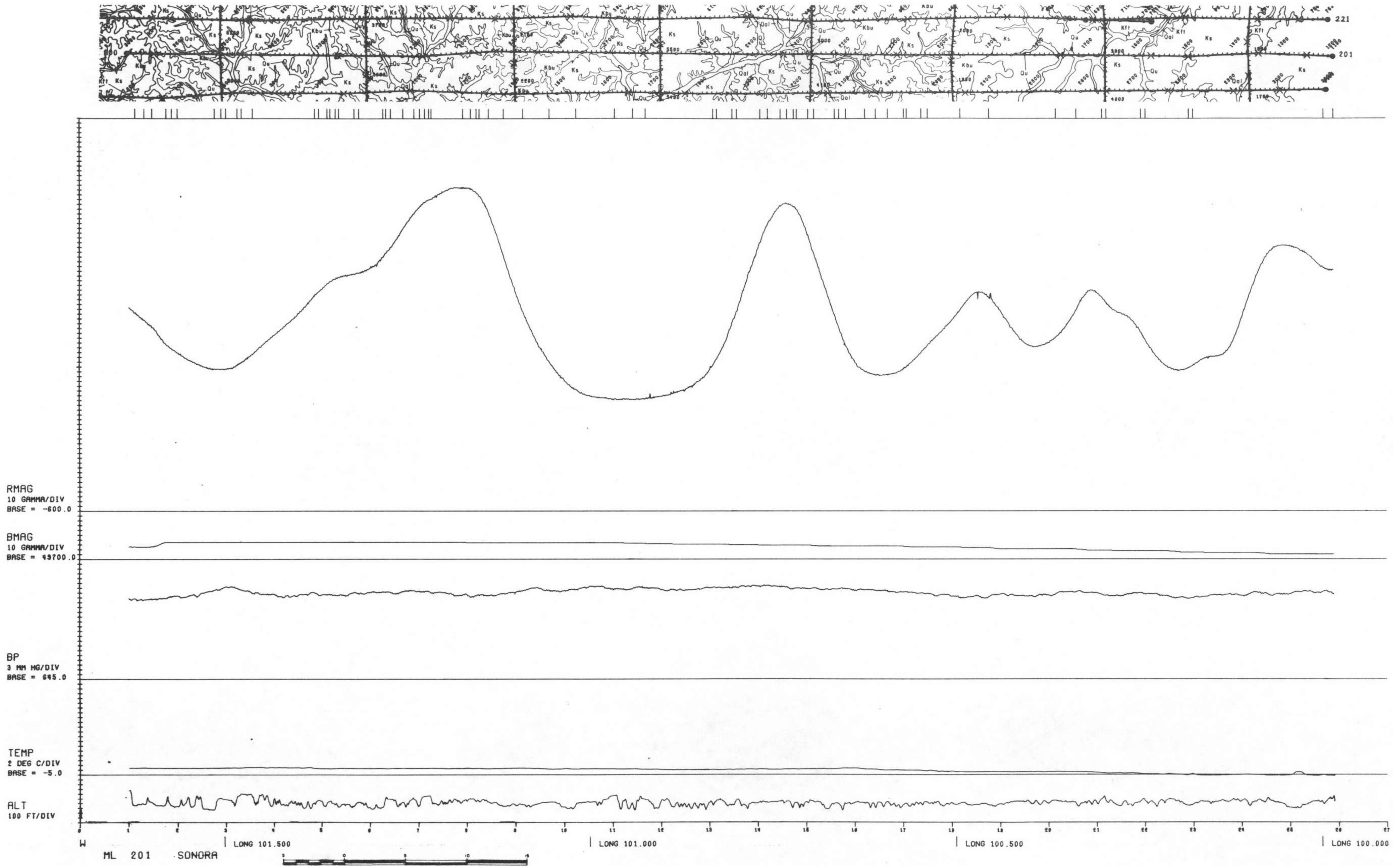
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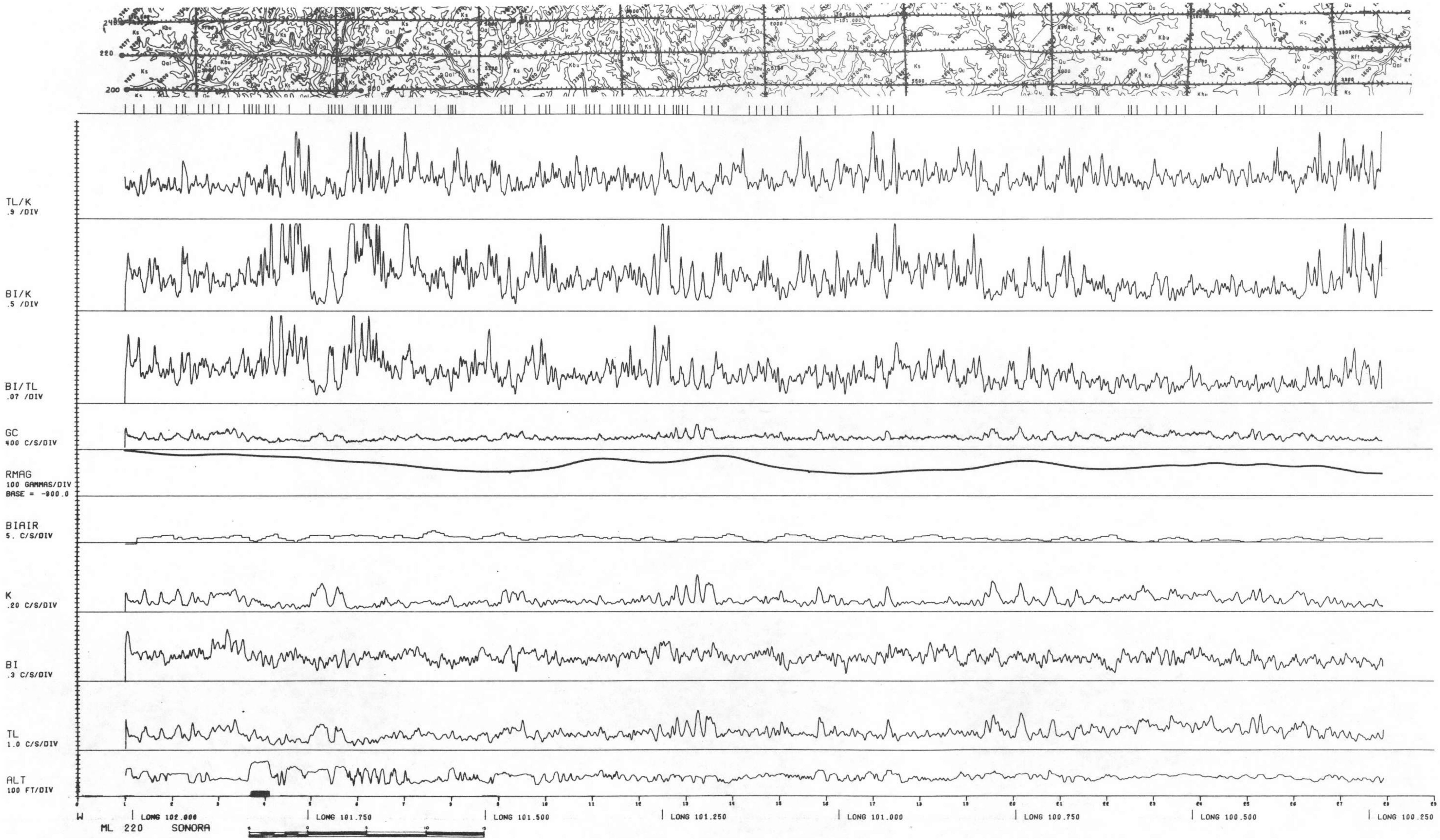
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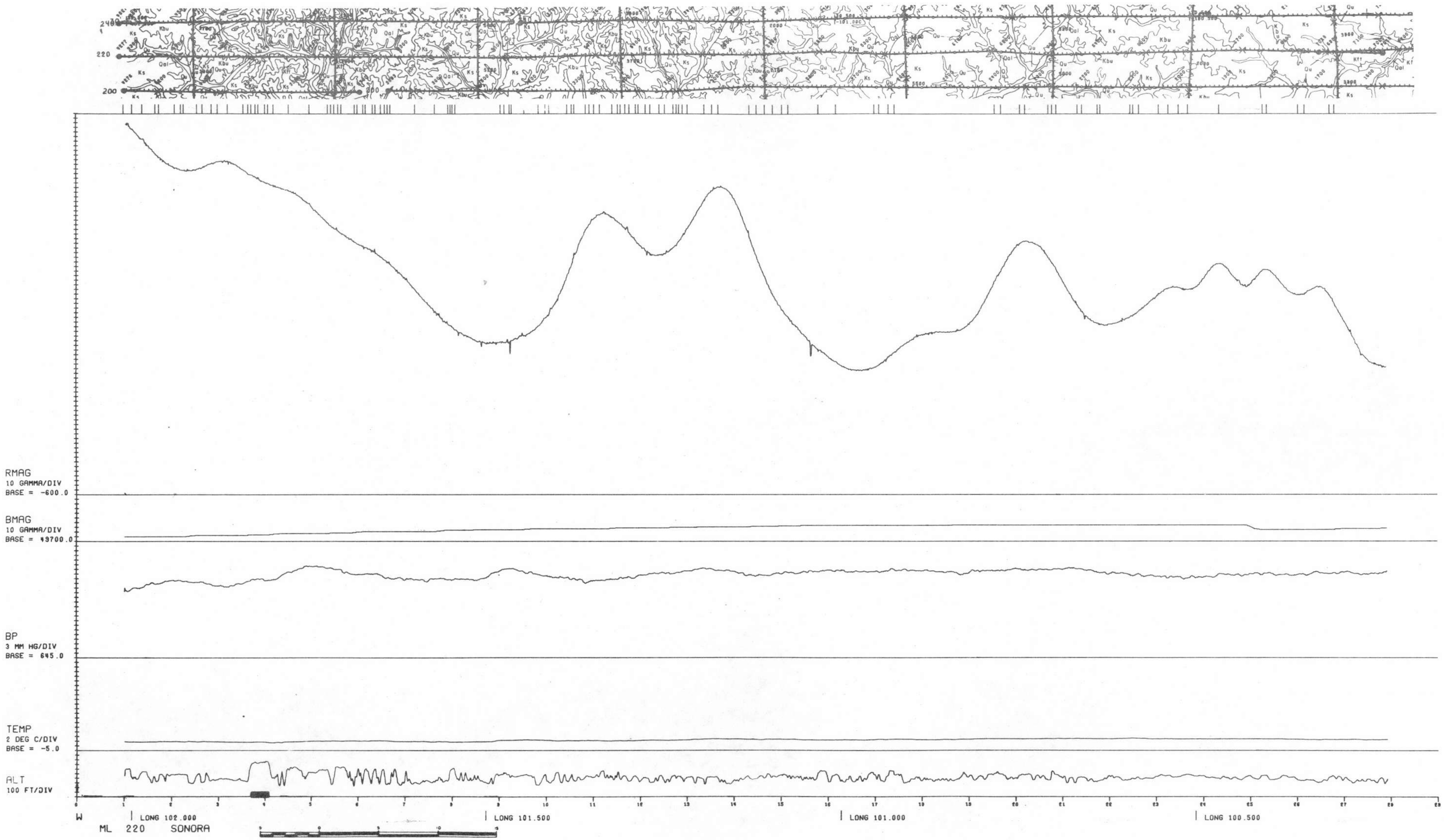
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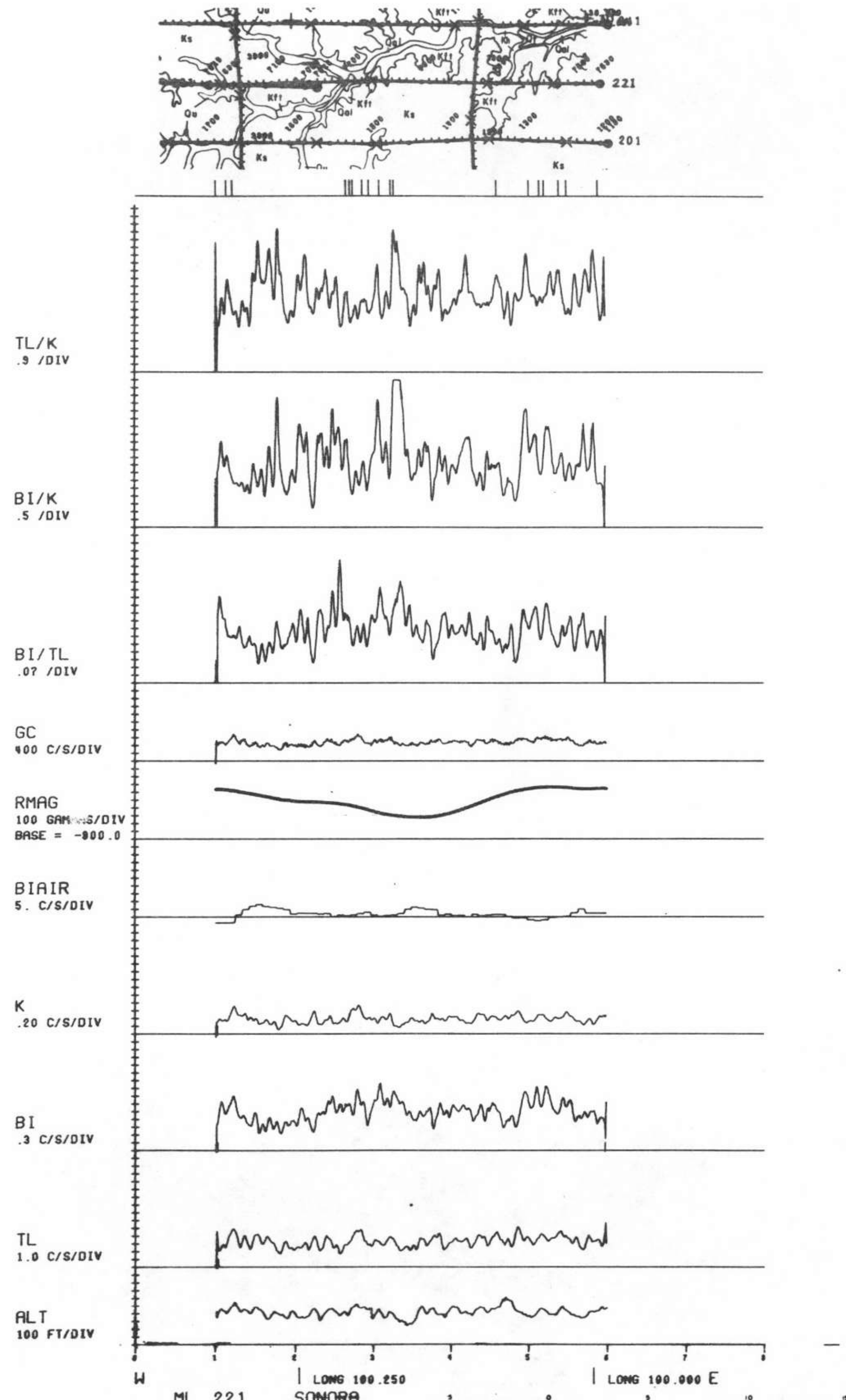
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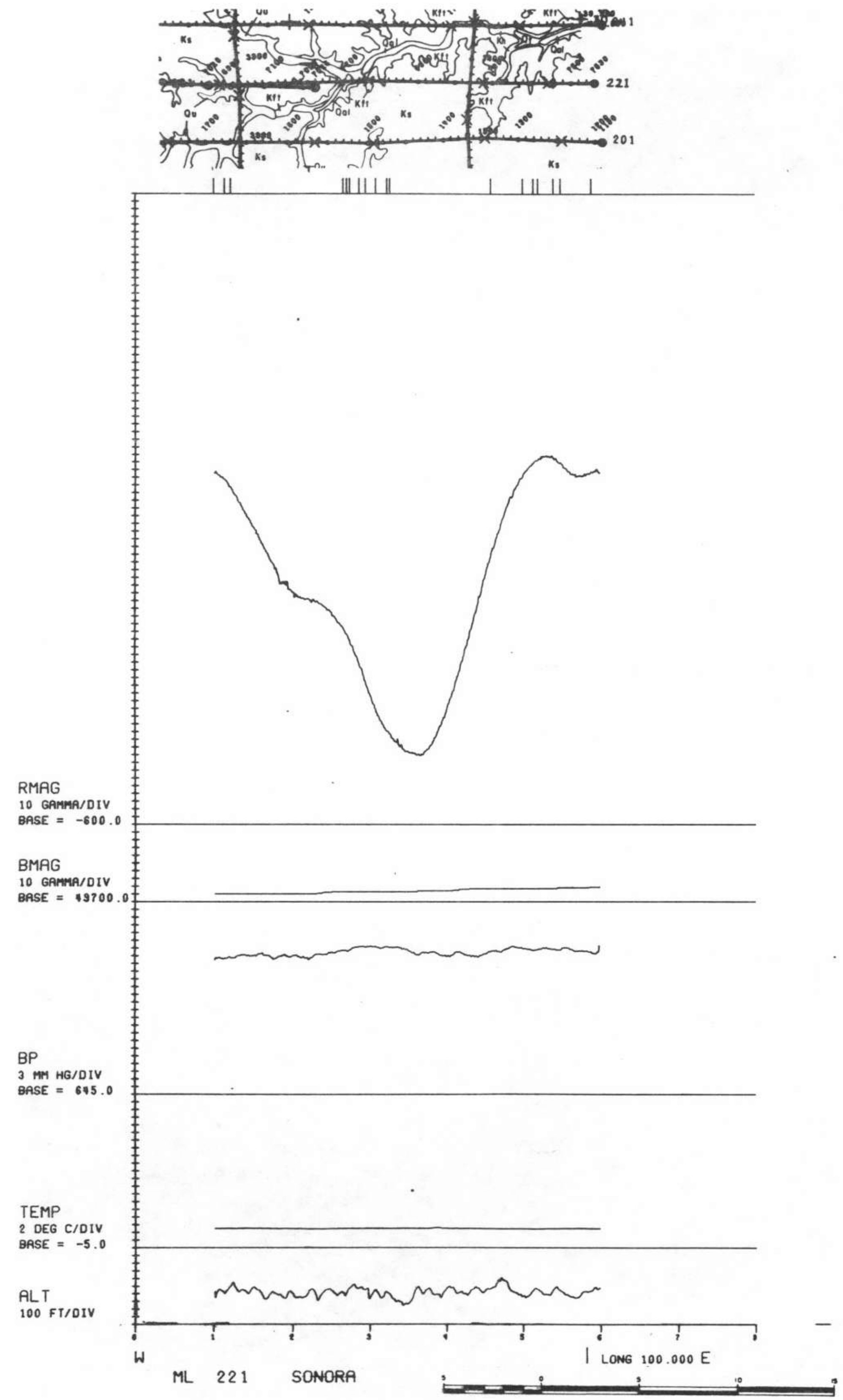

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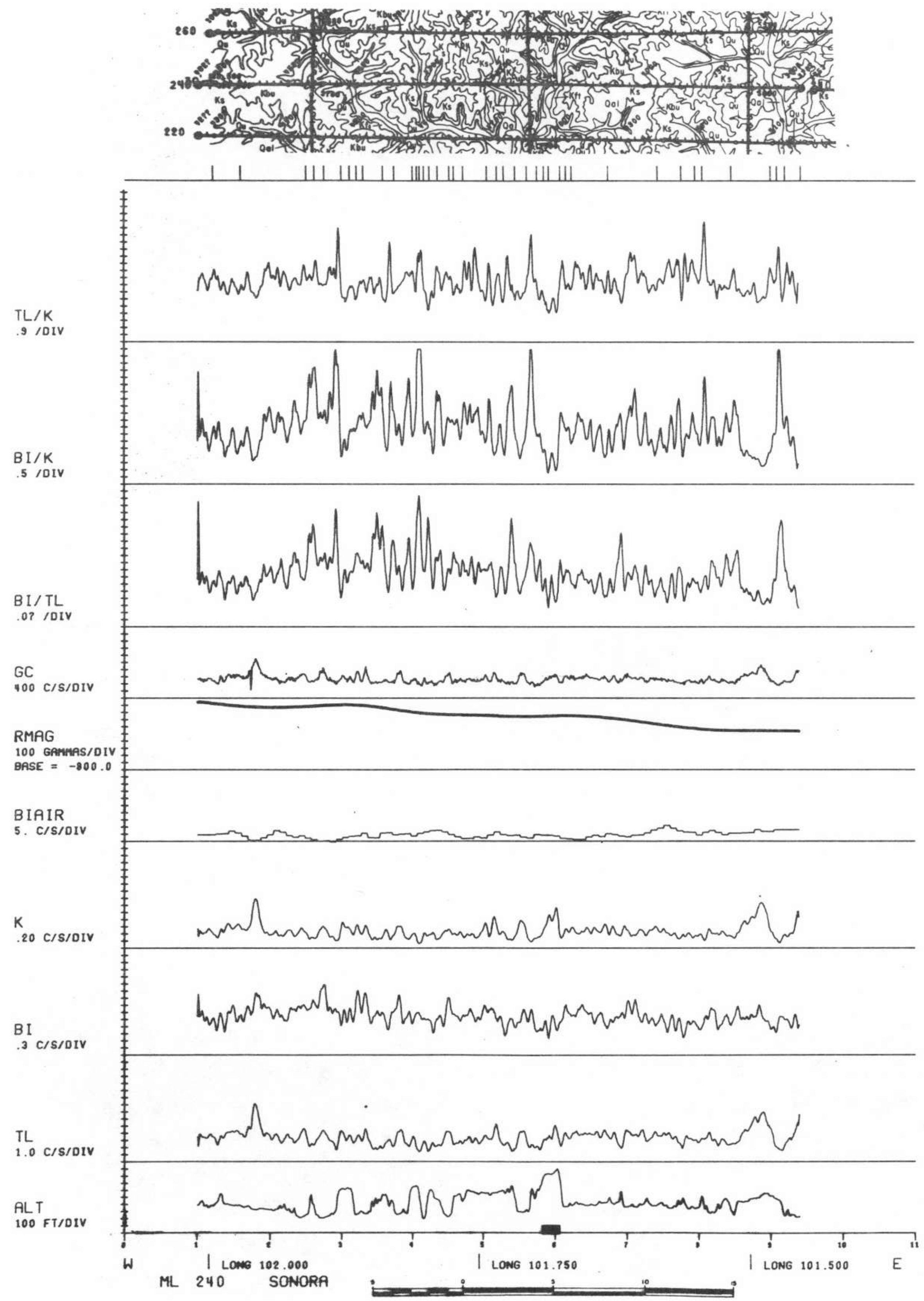

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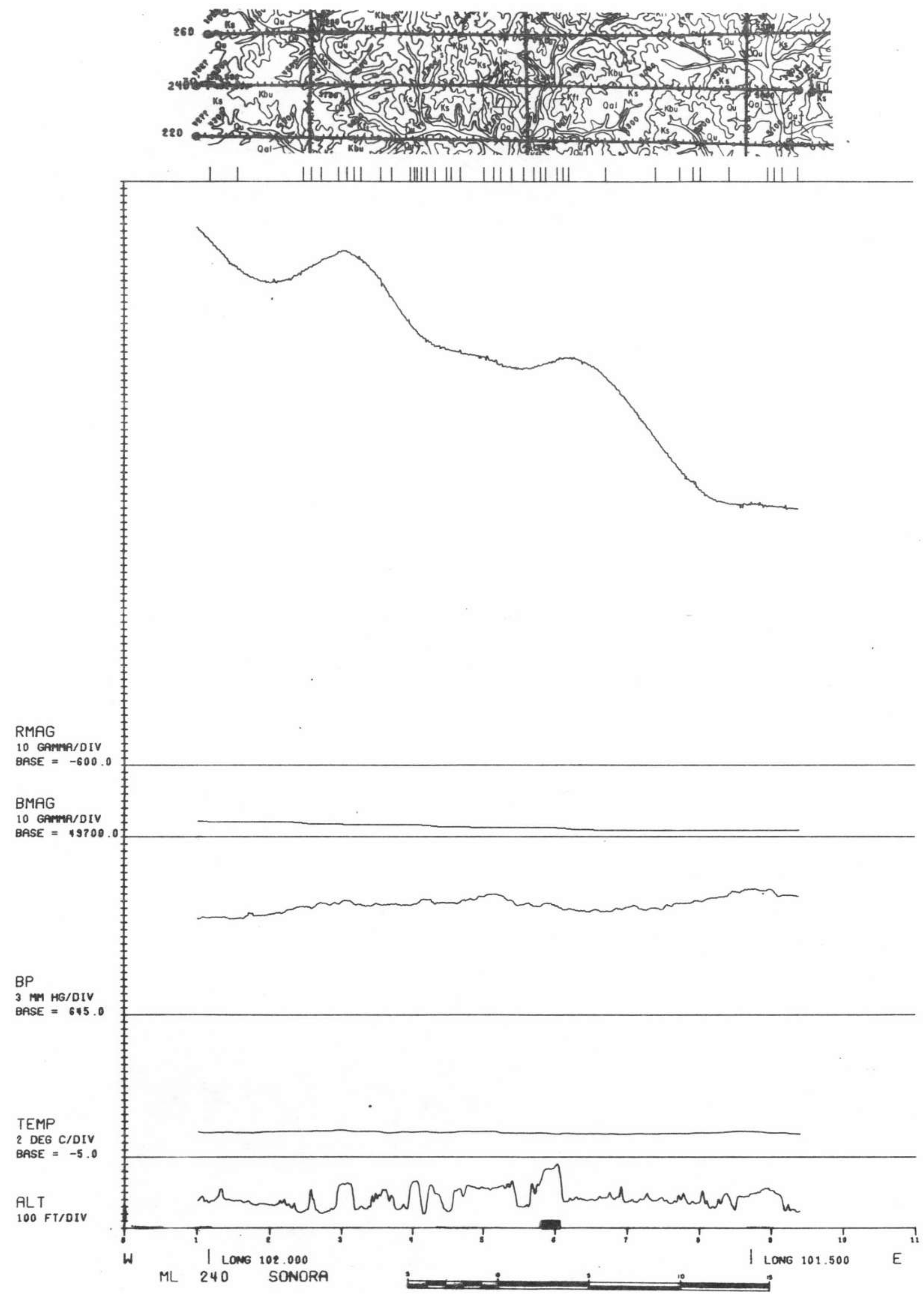
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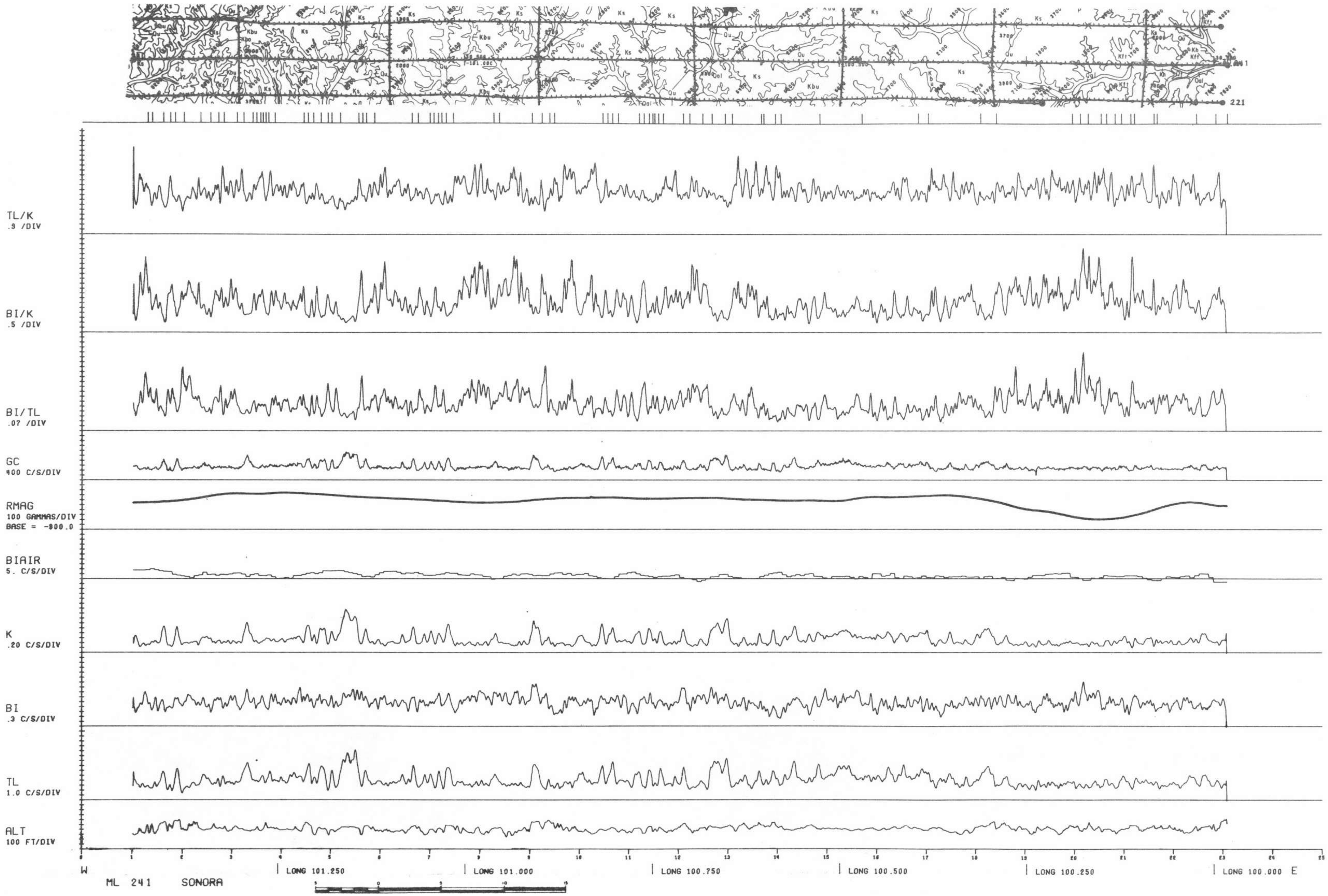
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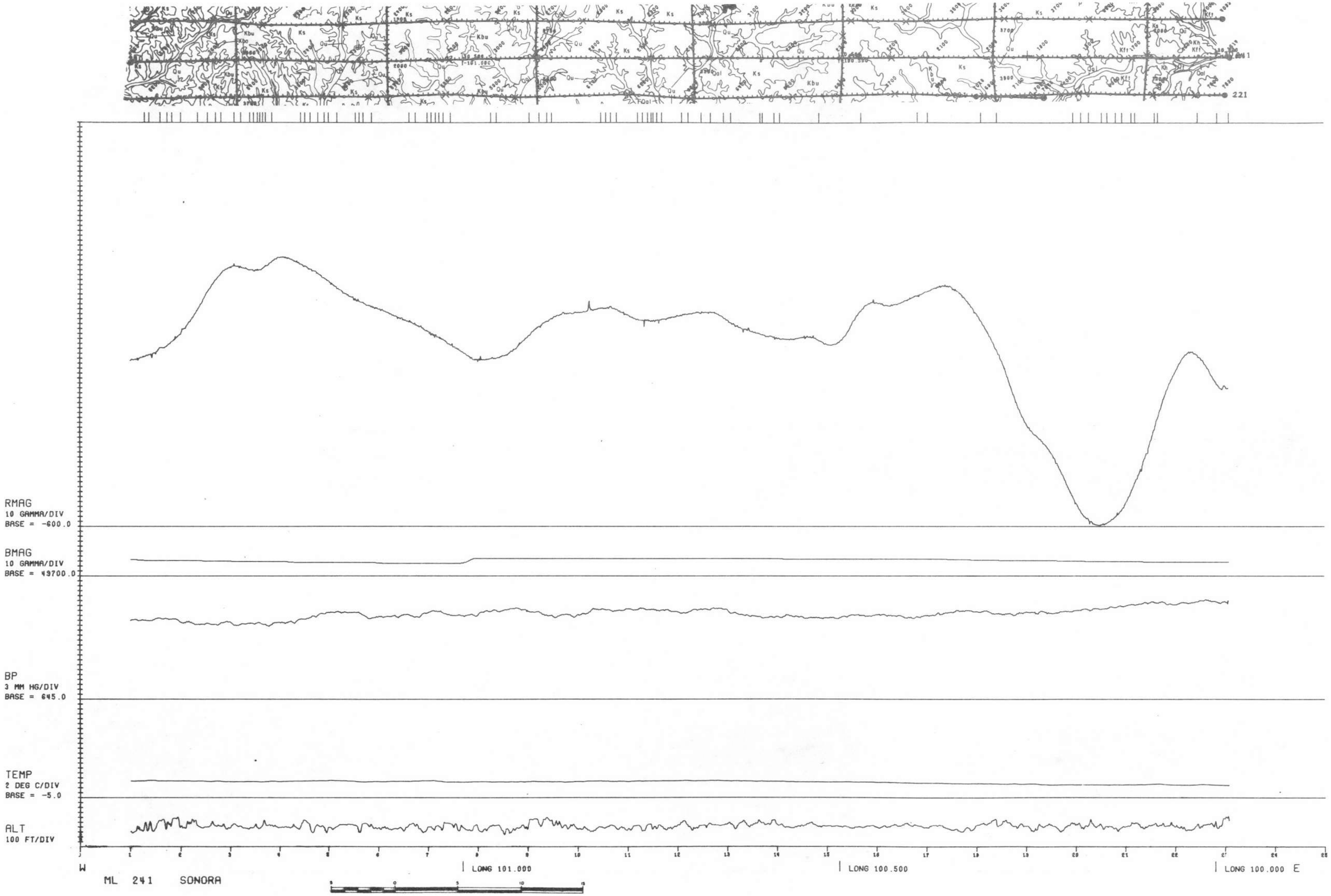
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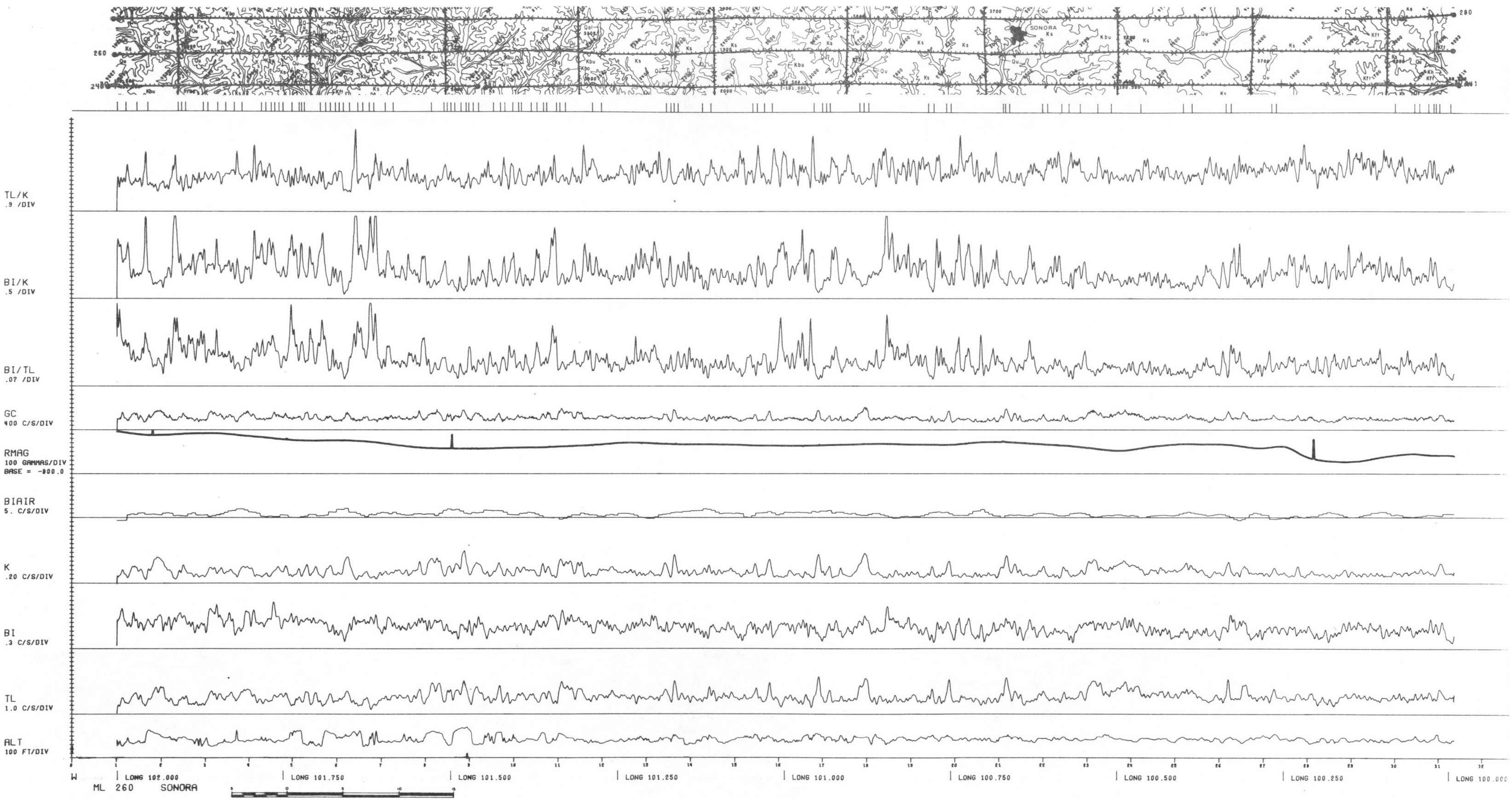

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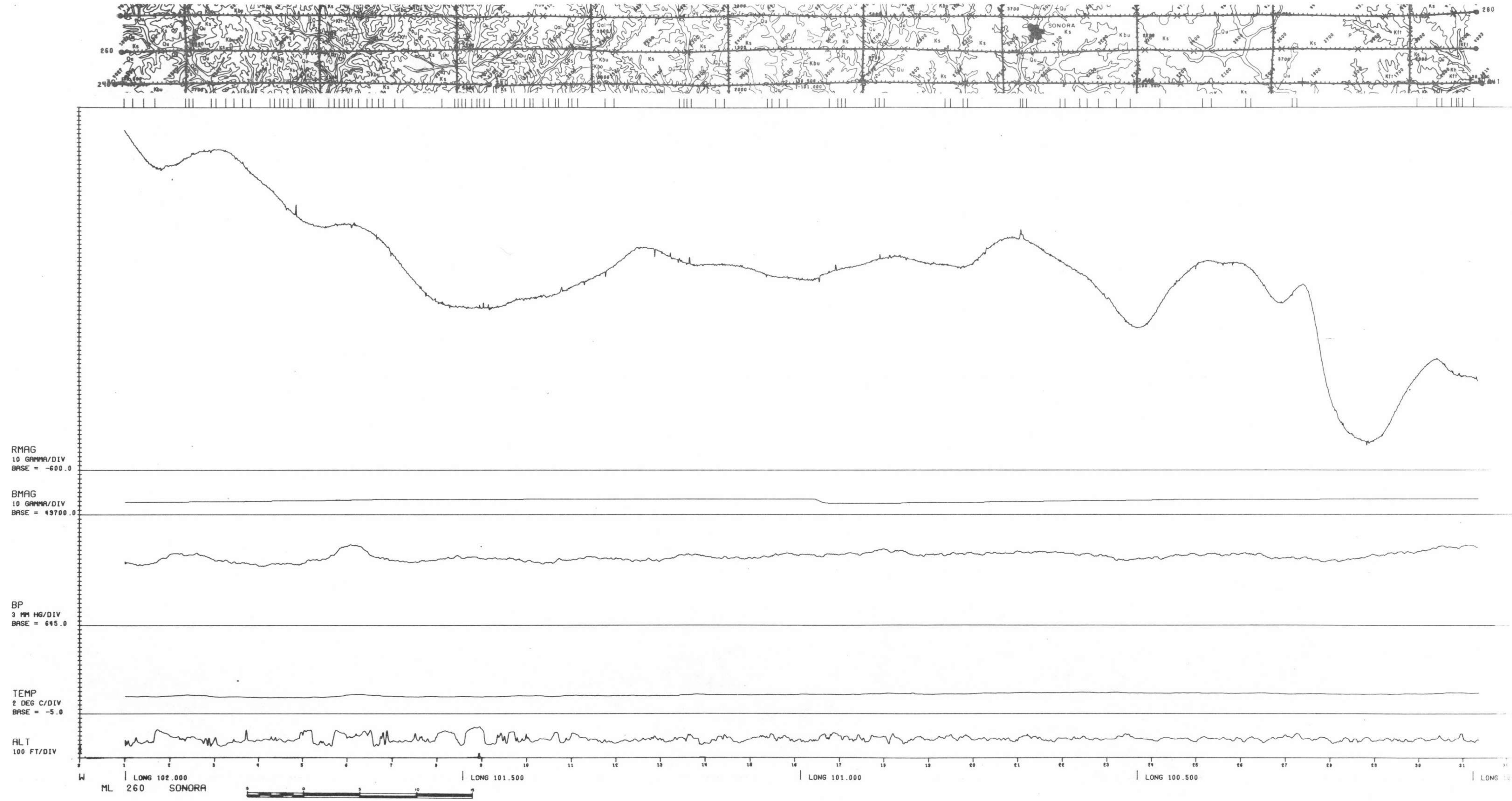
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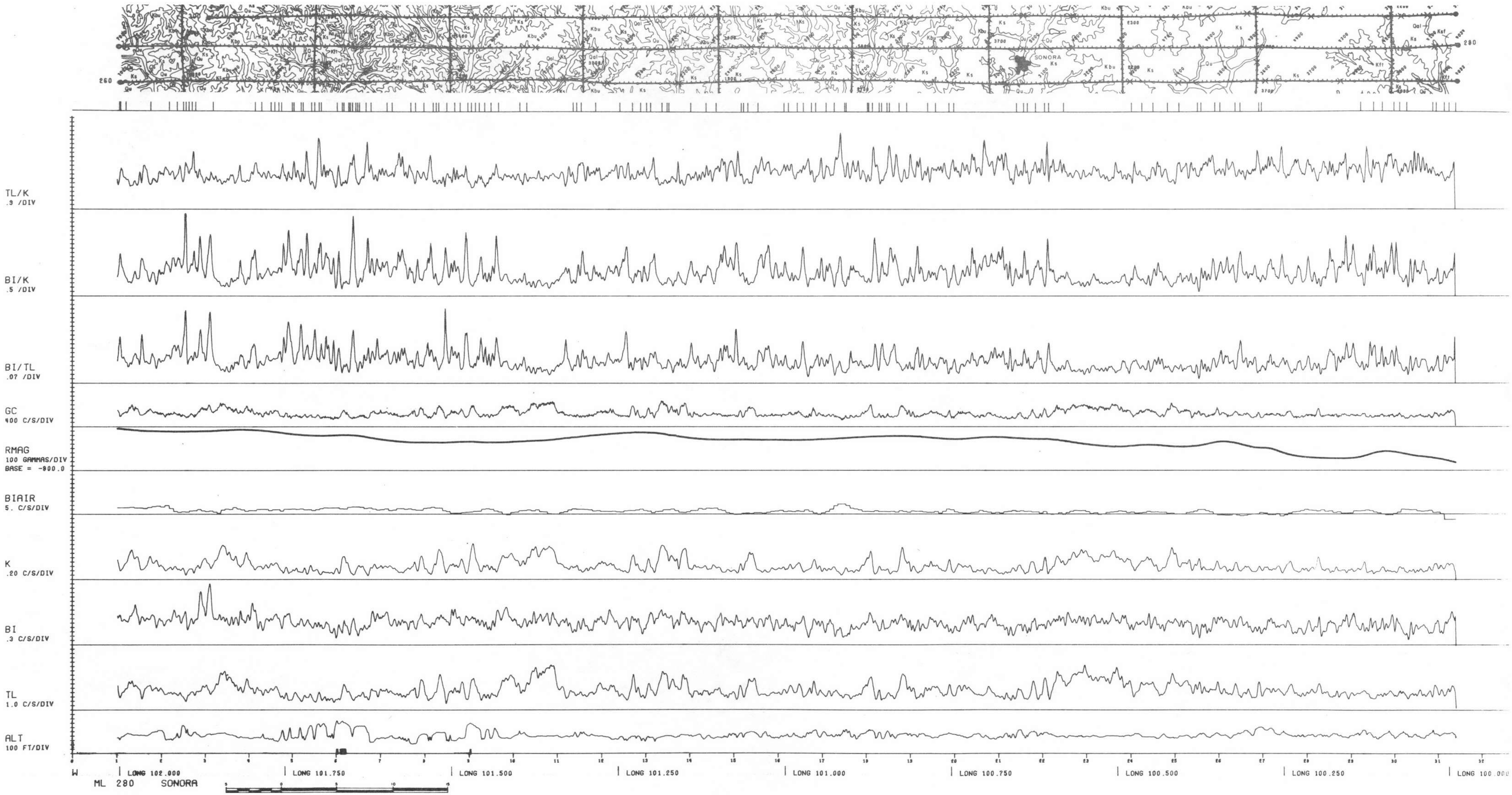

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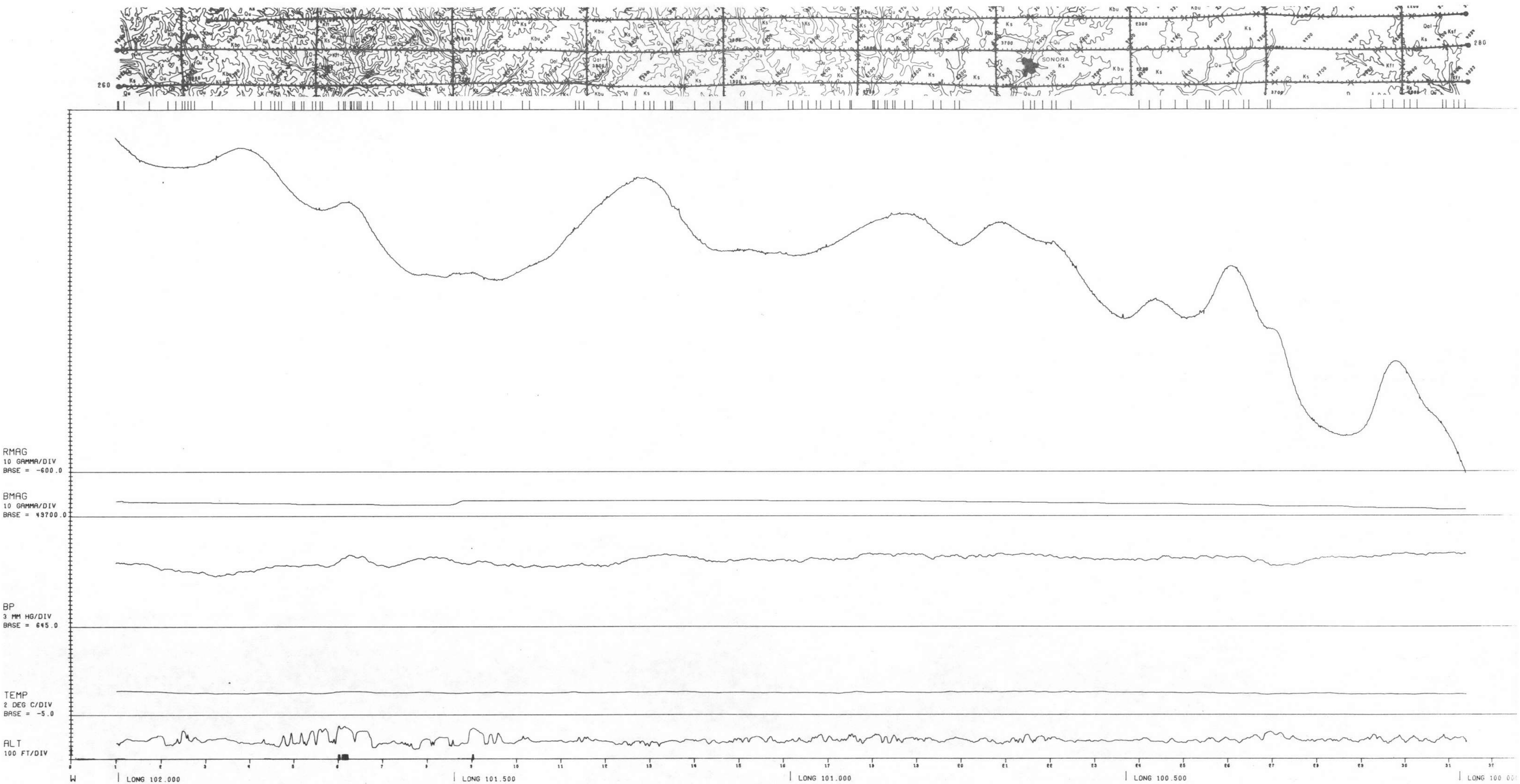

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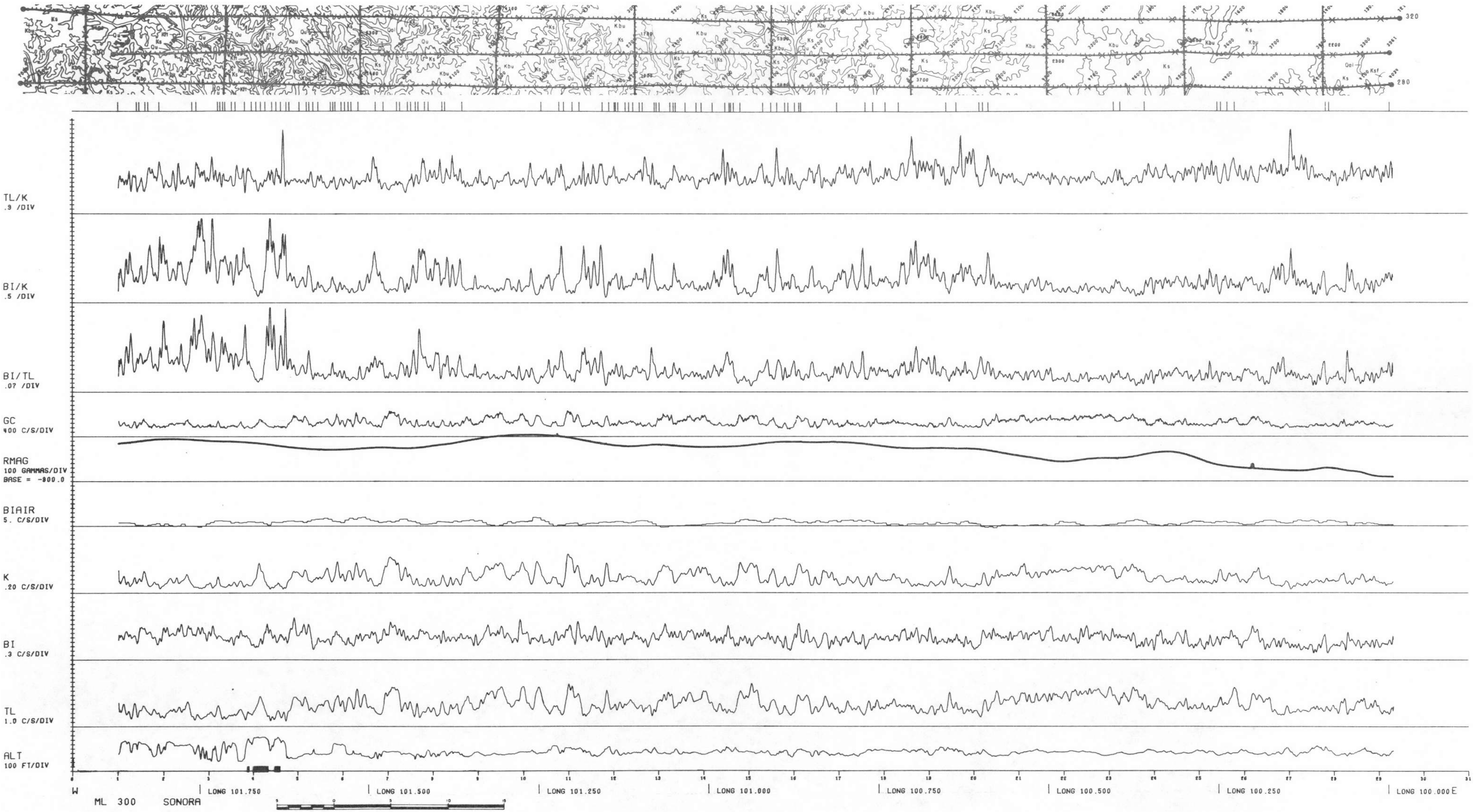
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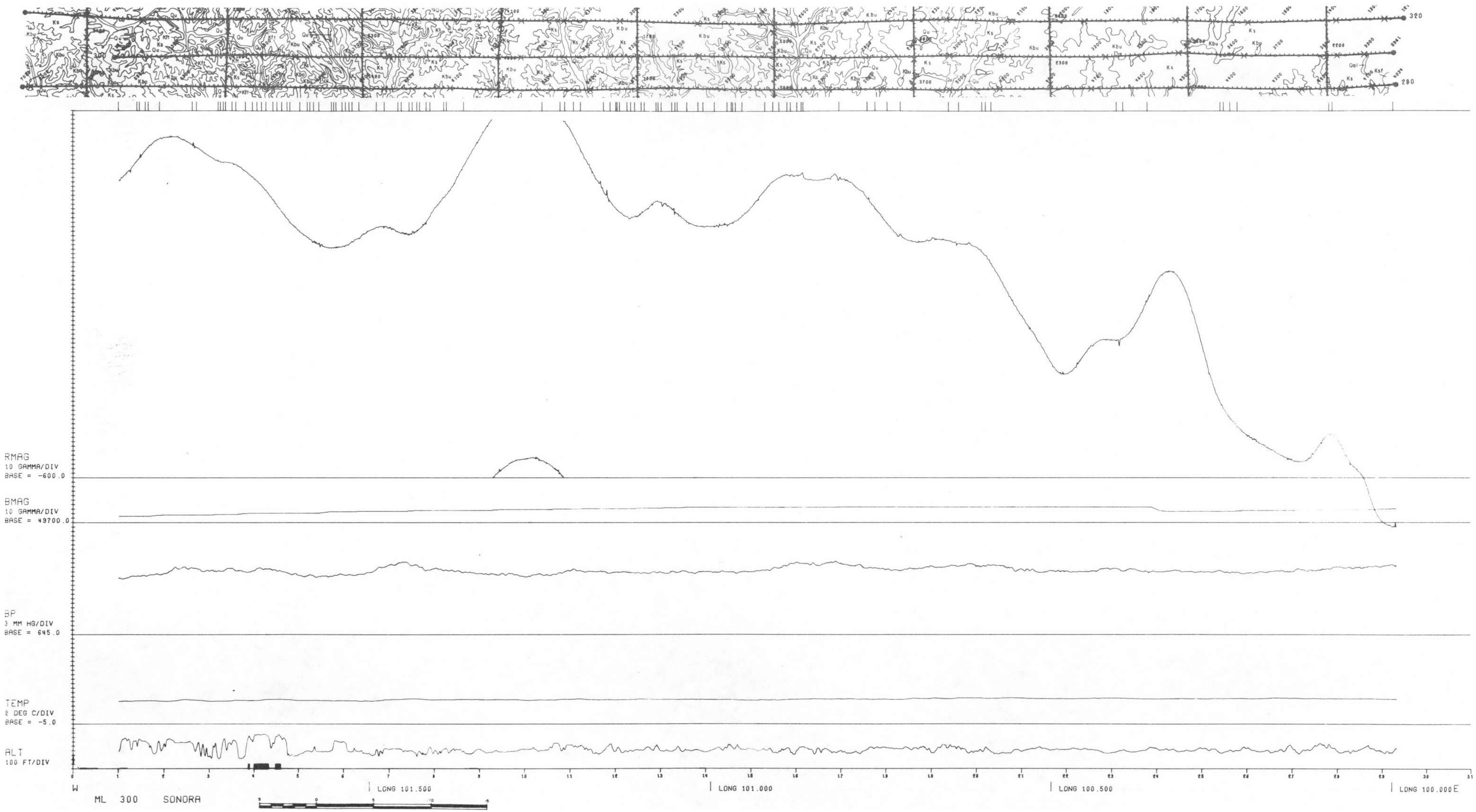
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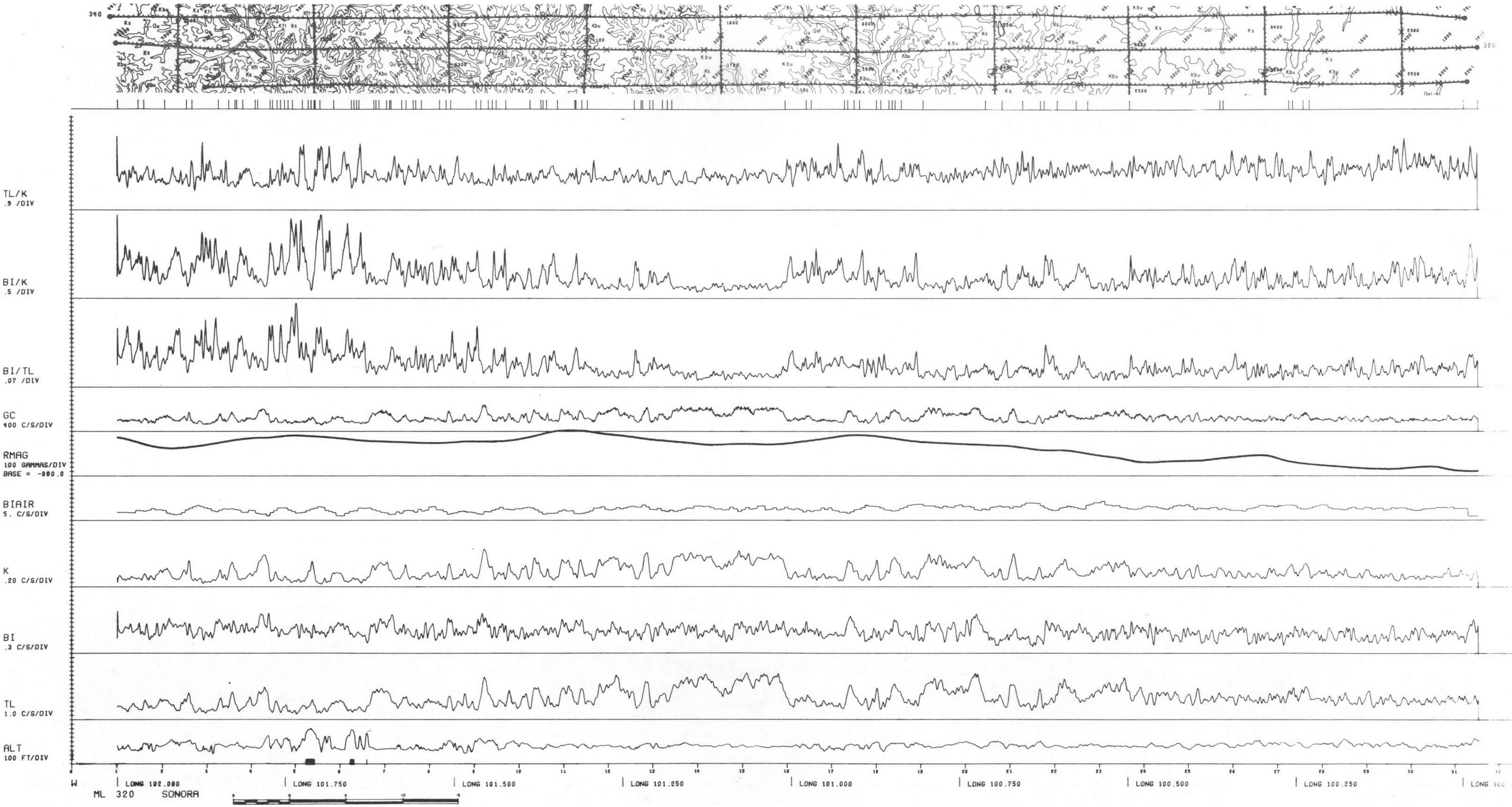
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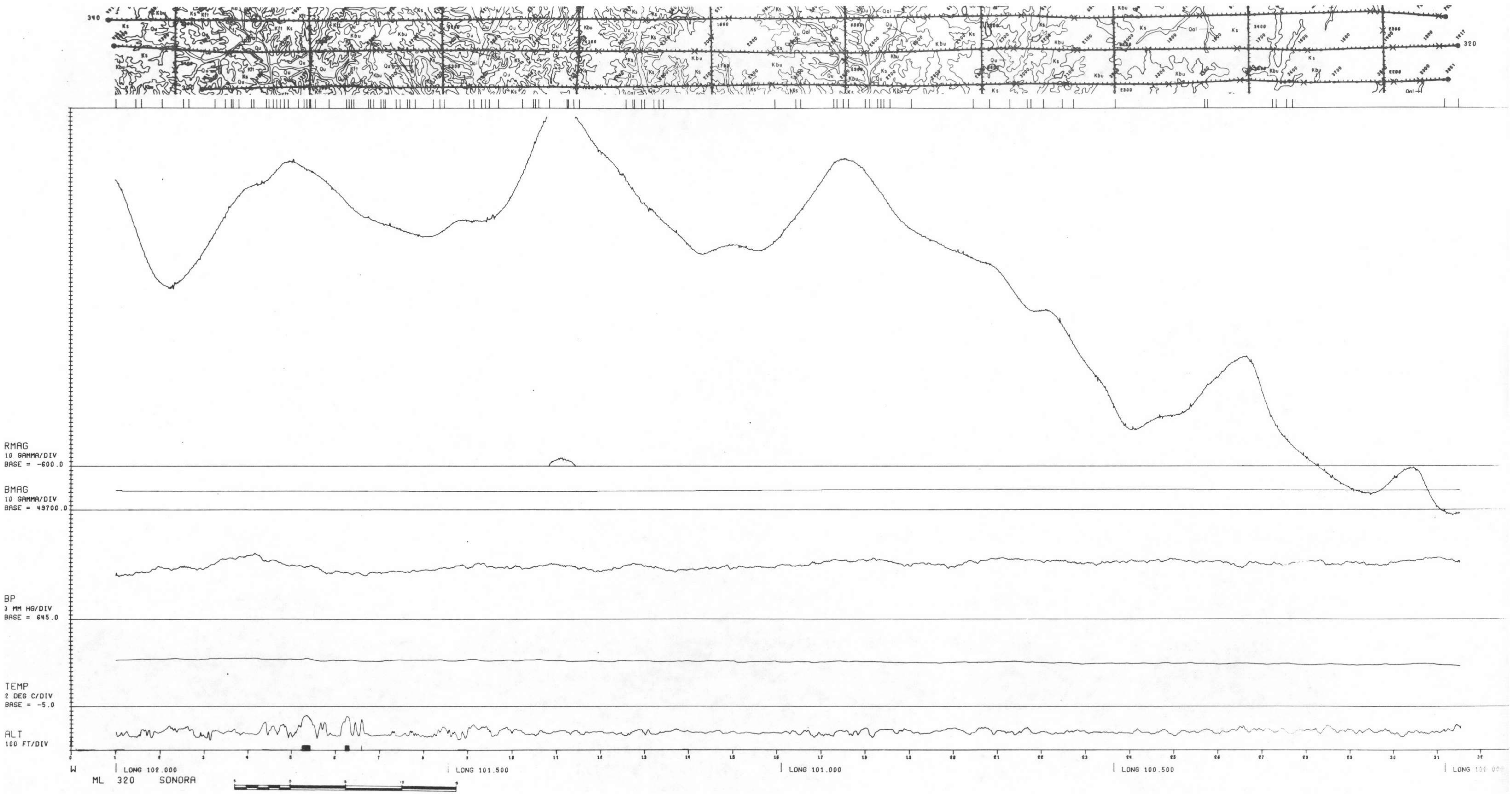
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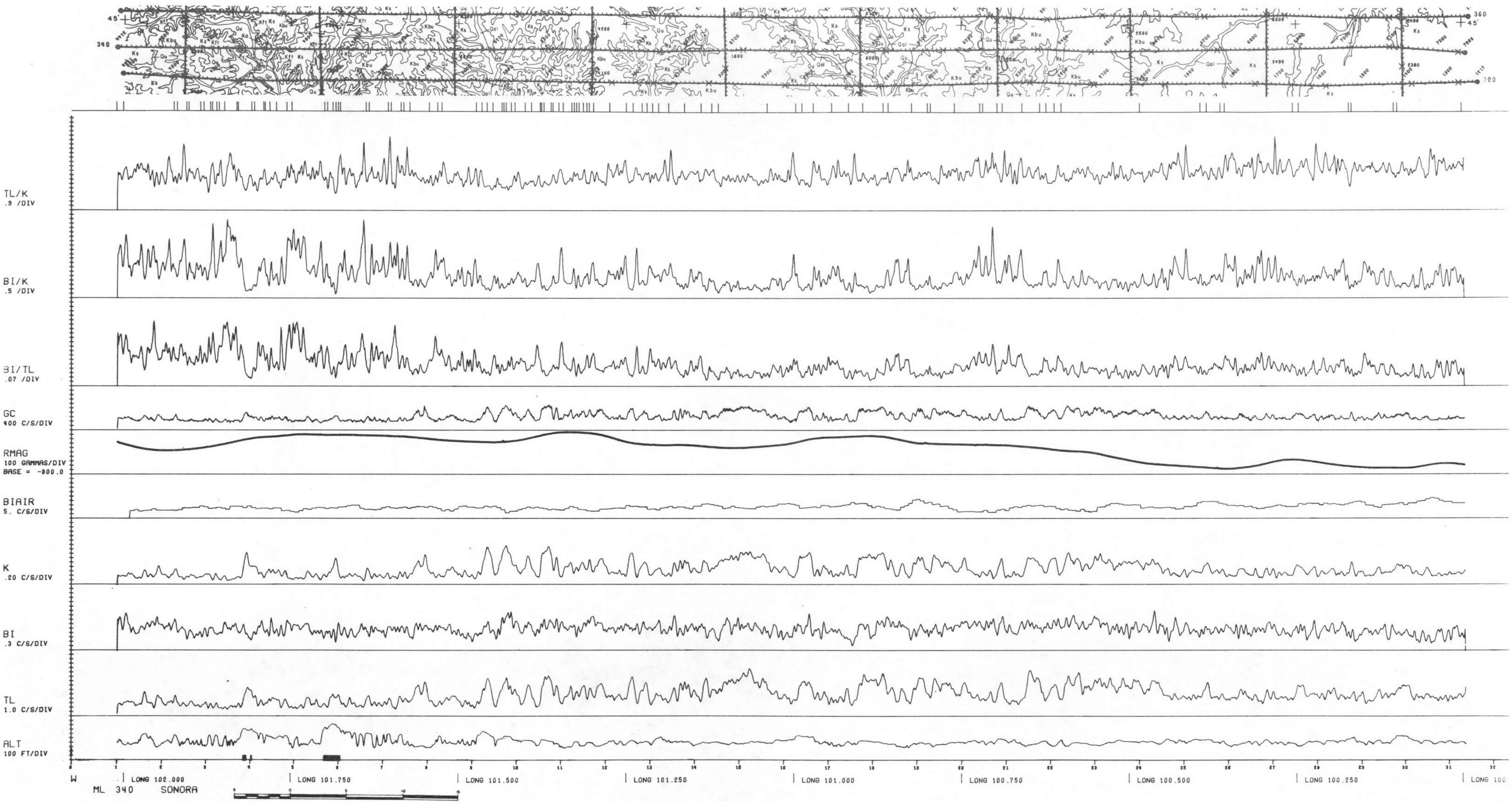
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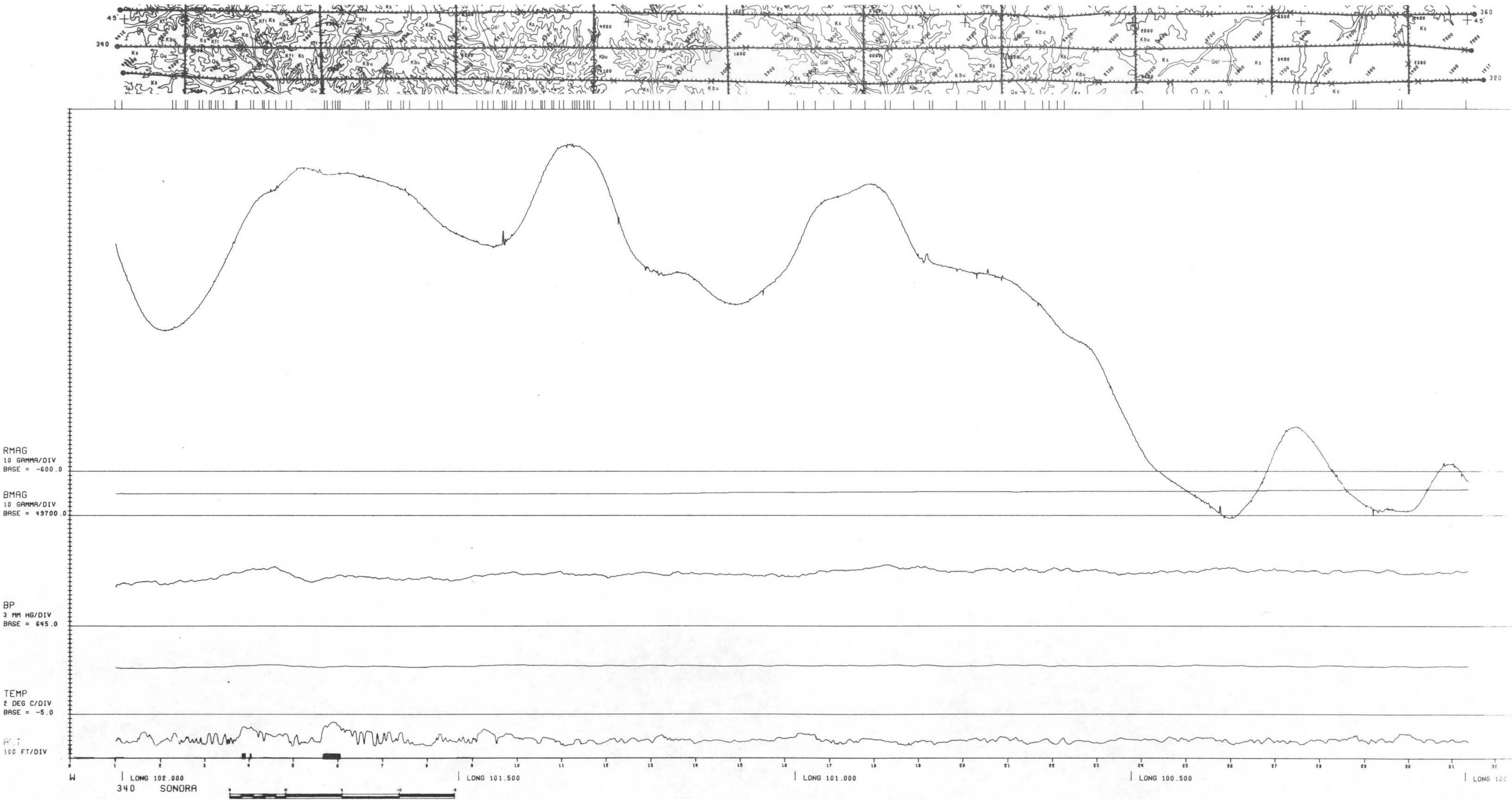
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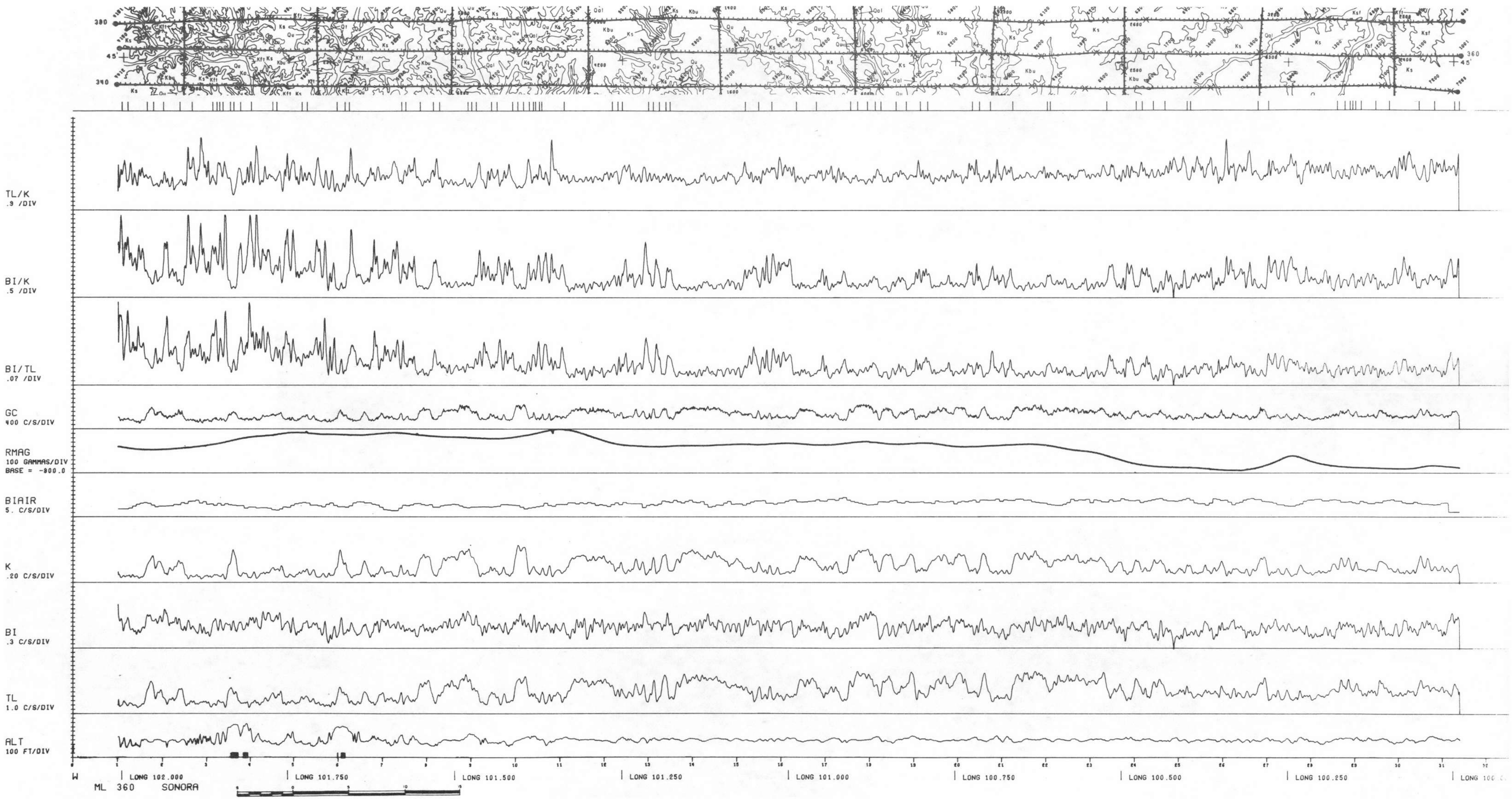

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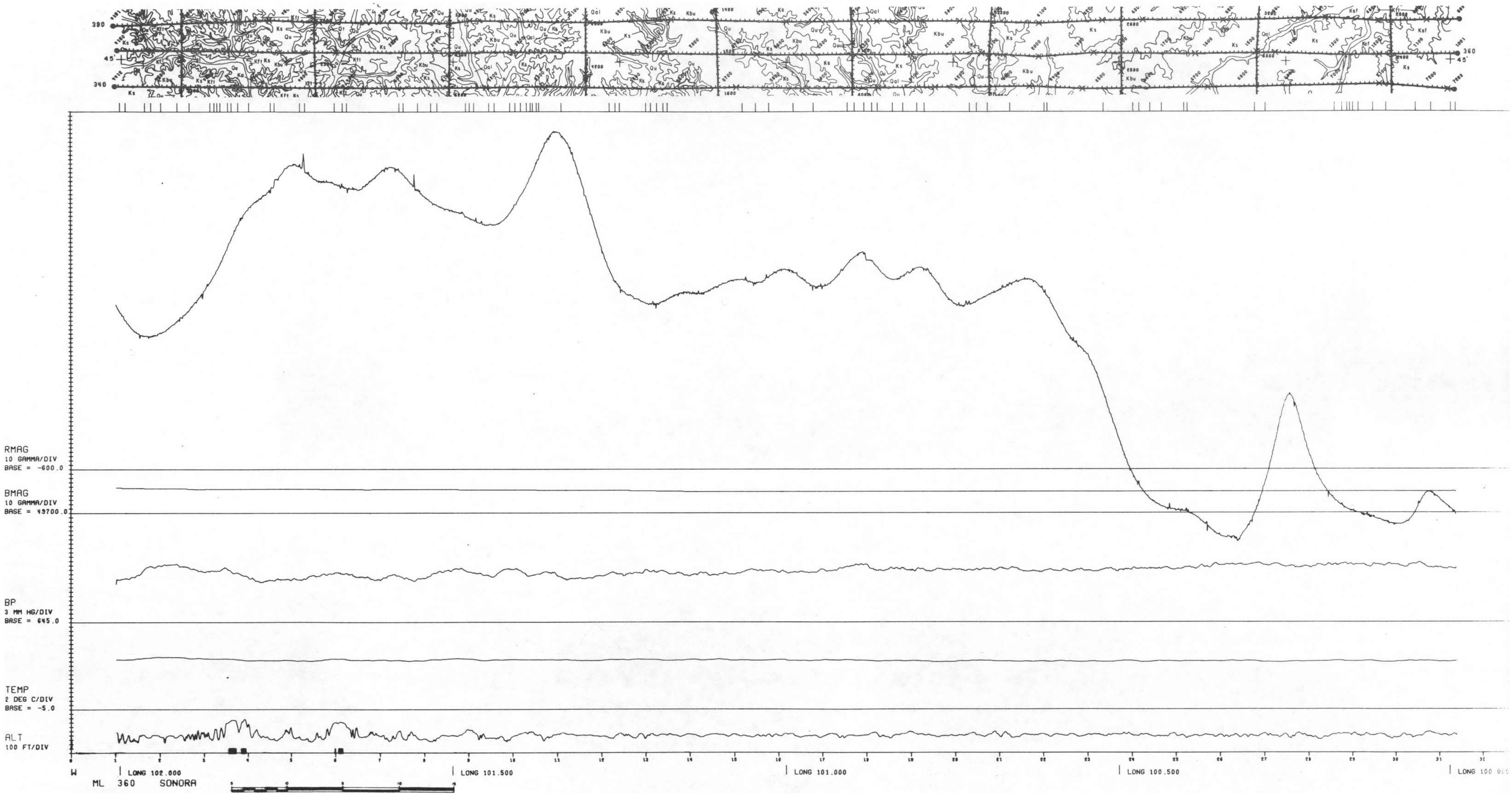
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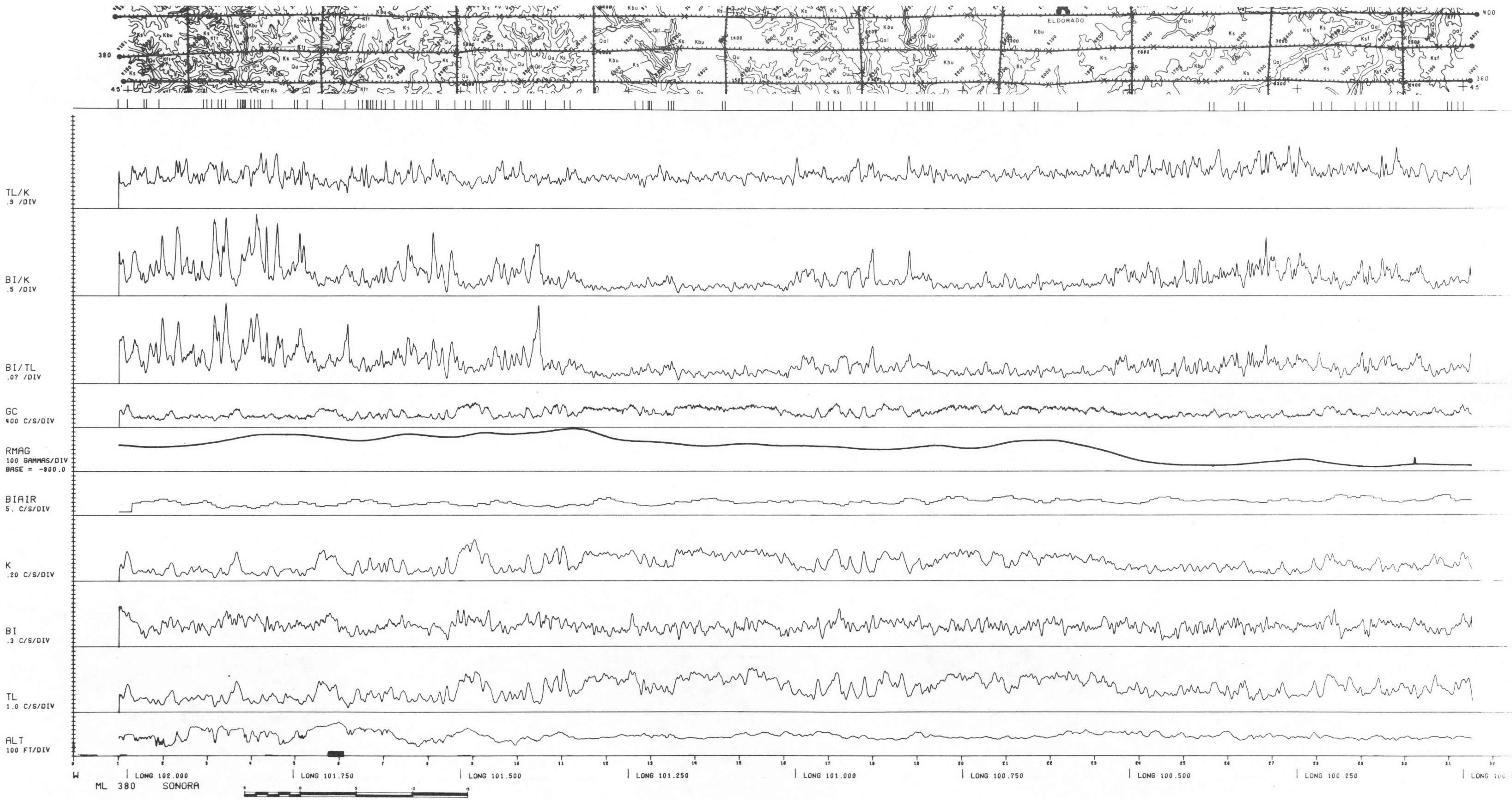
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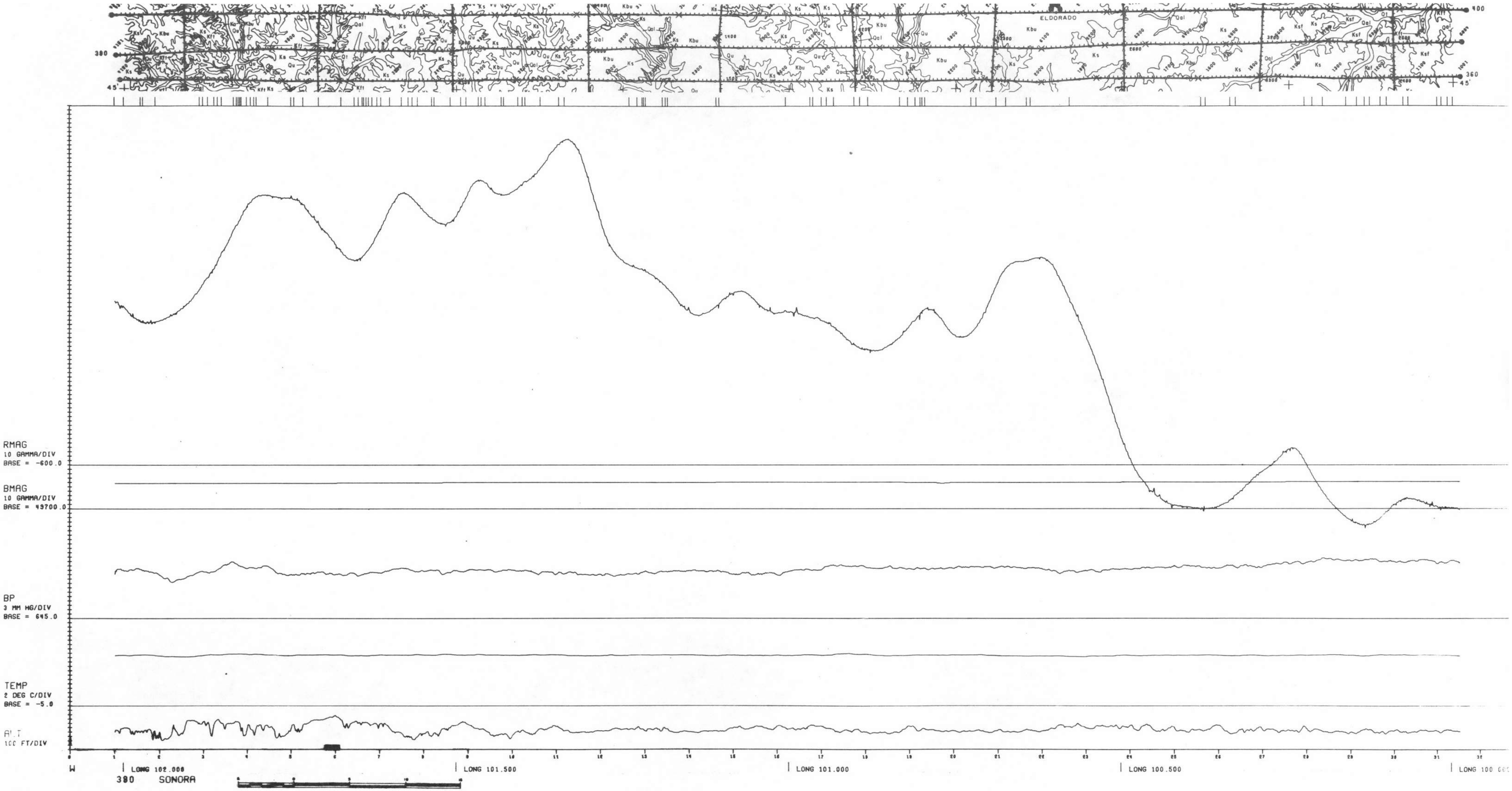
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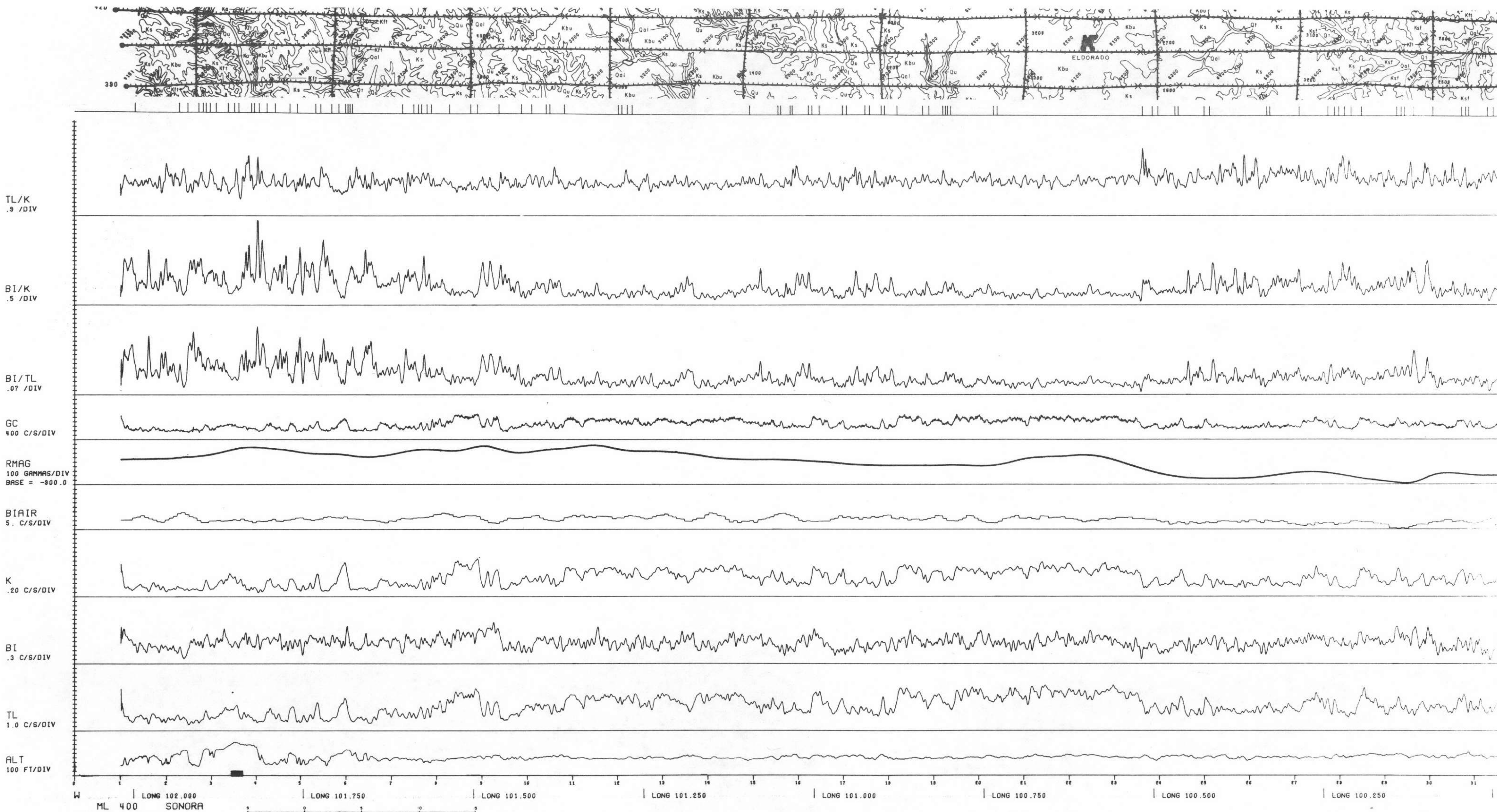

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BI
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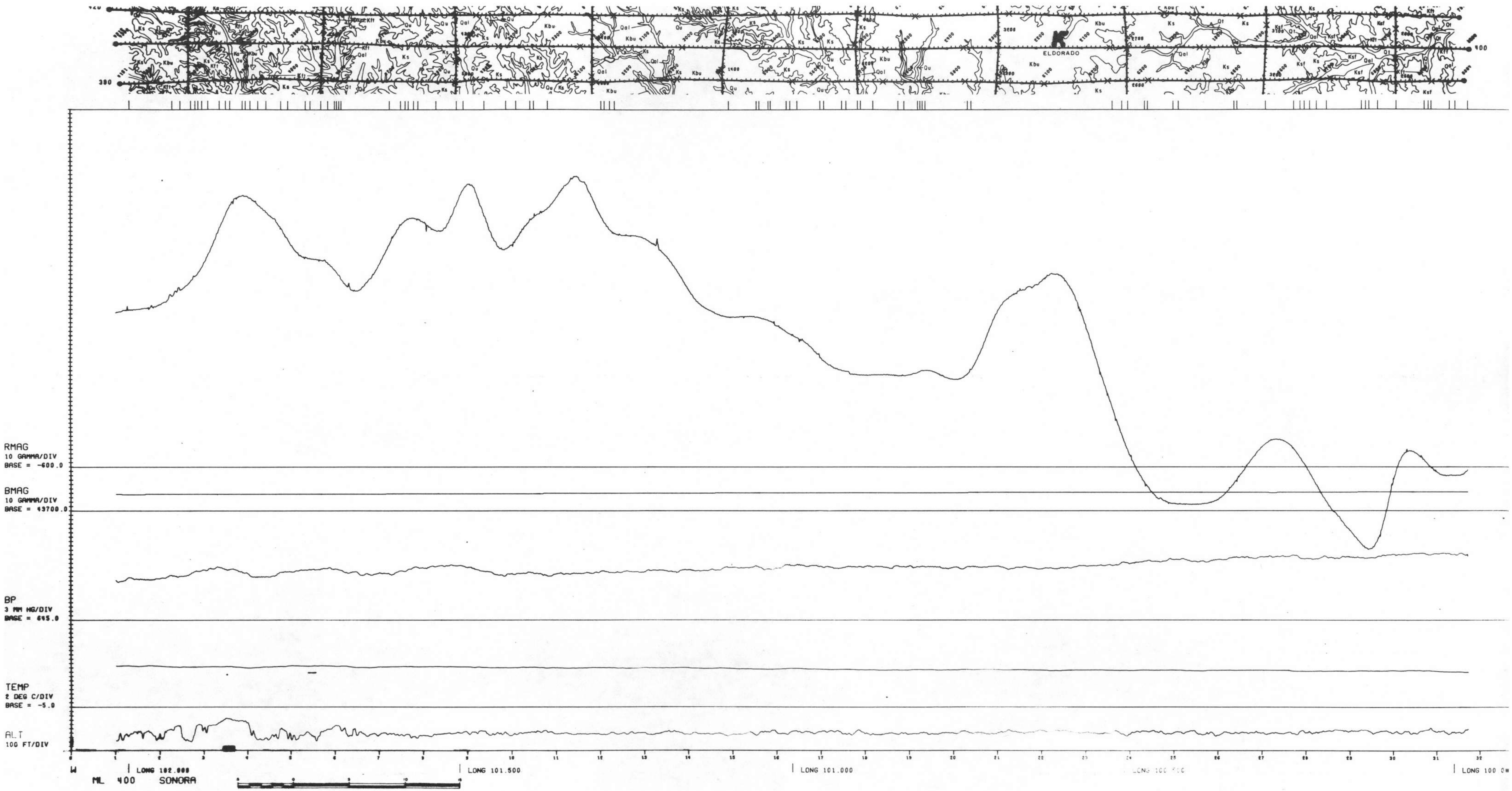

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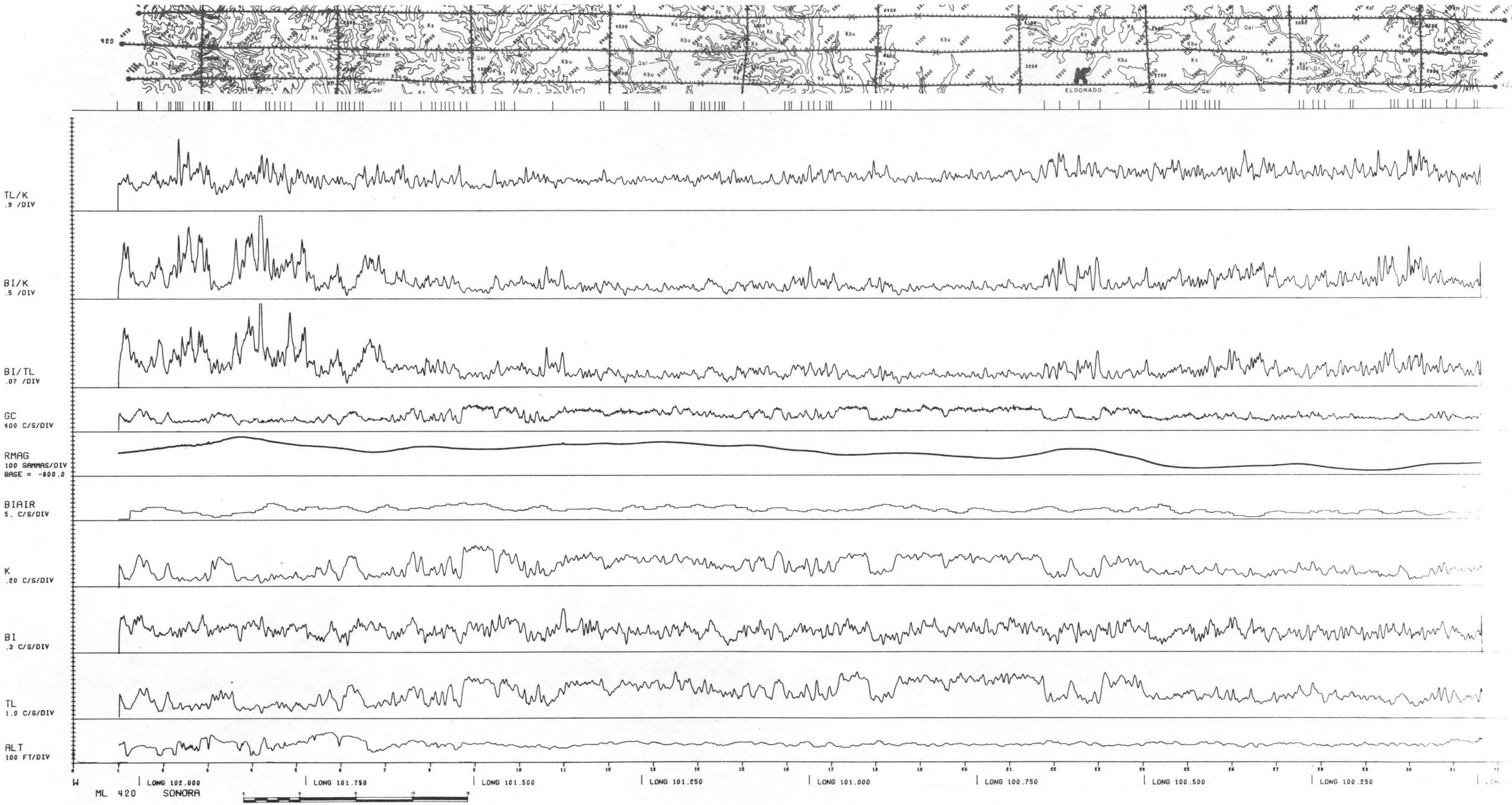

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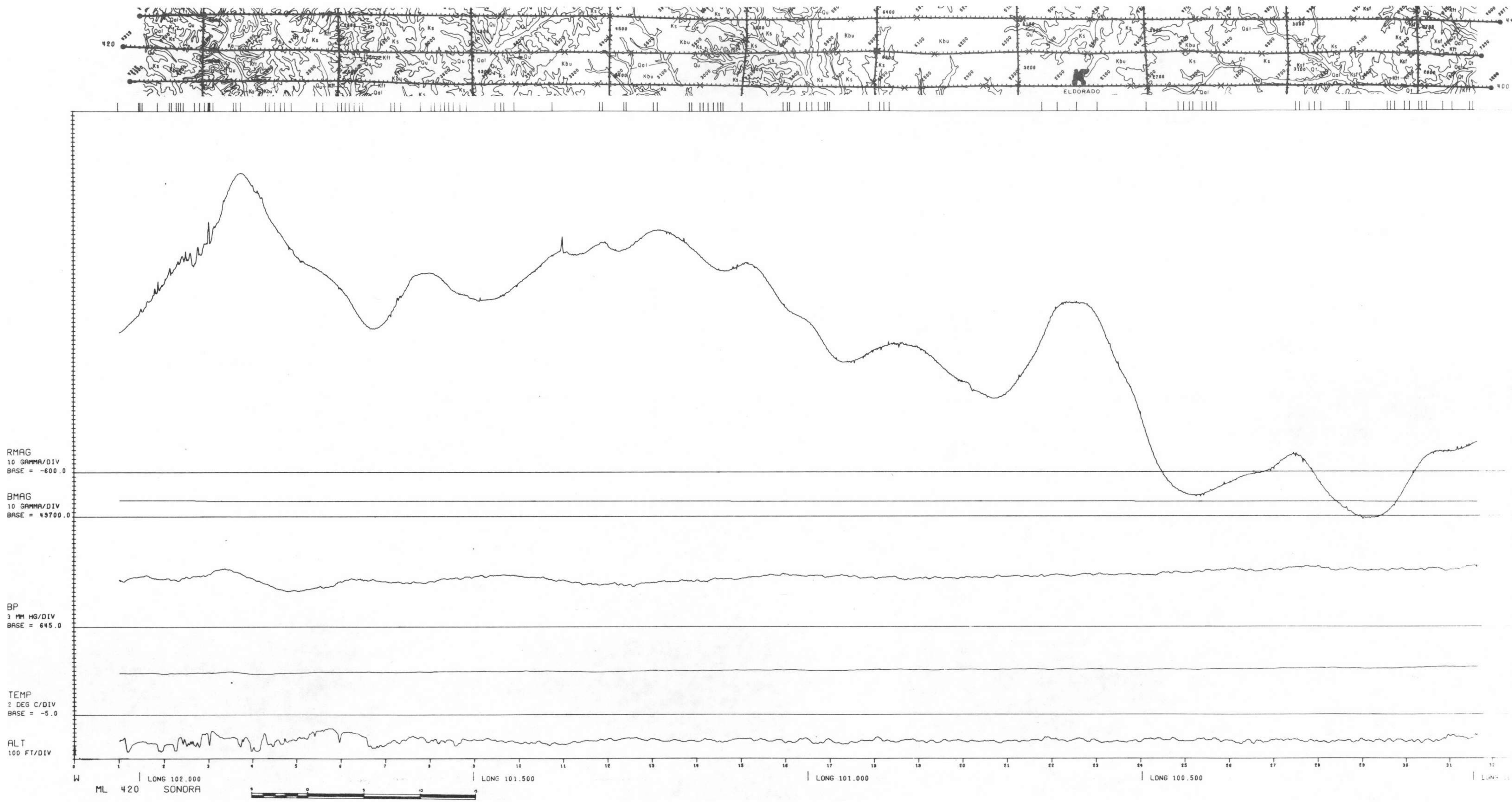

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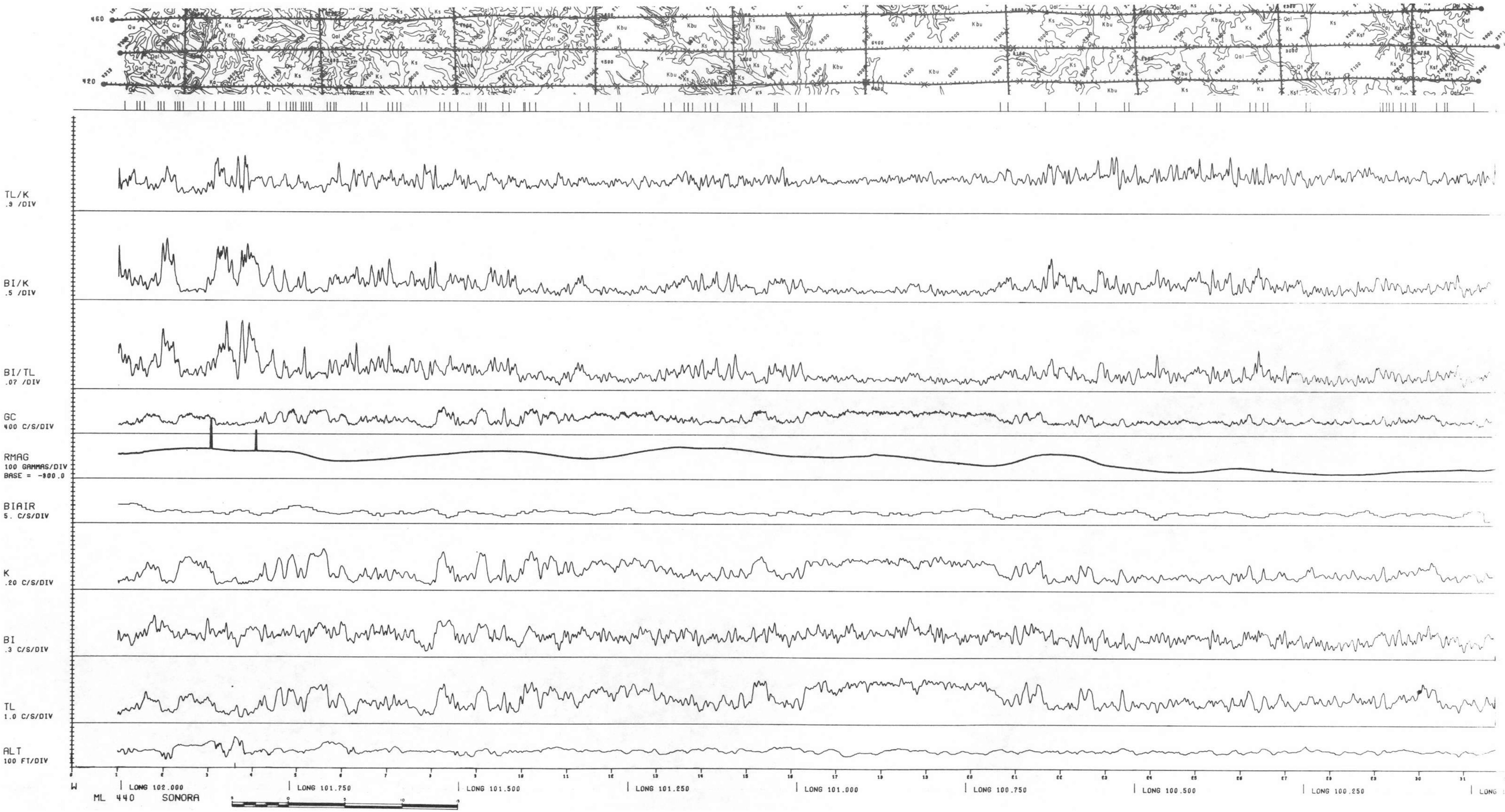
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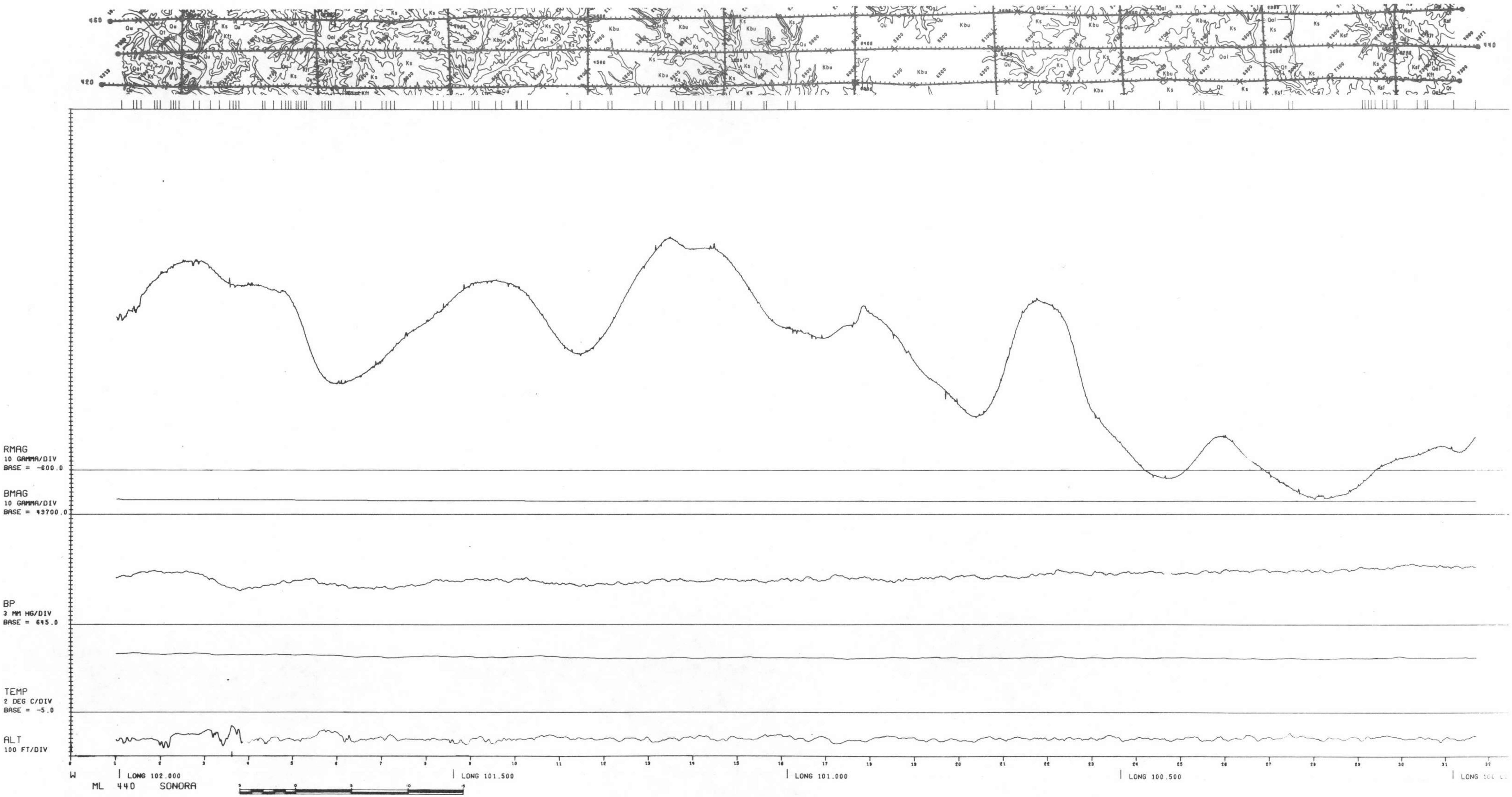
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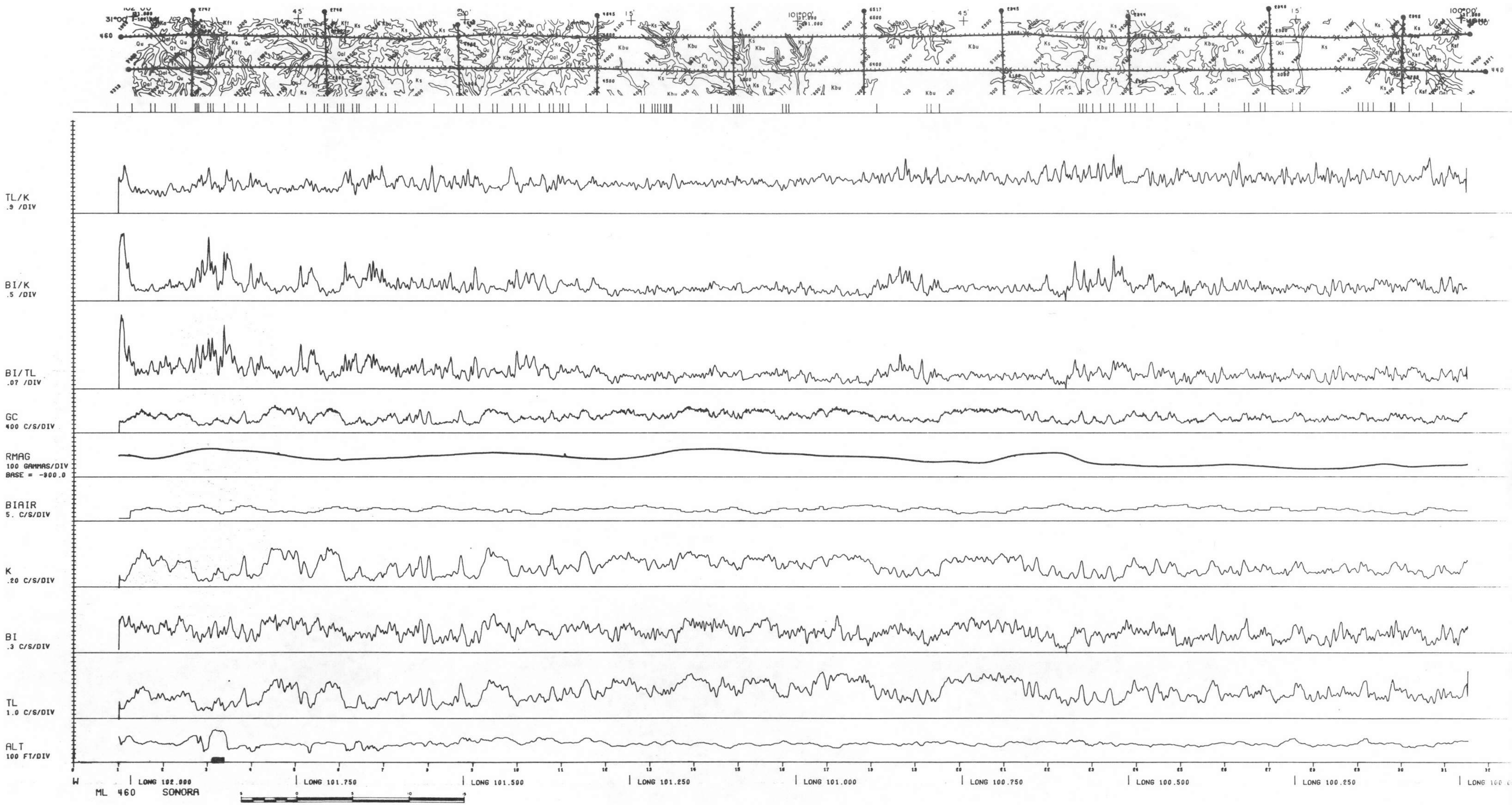
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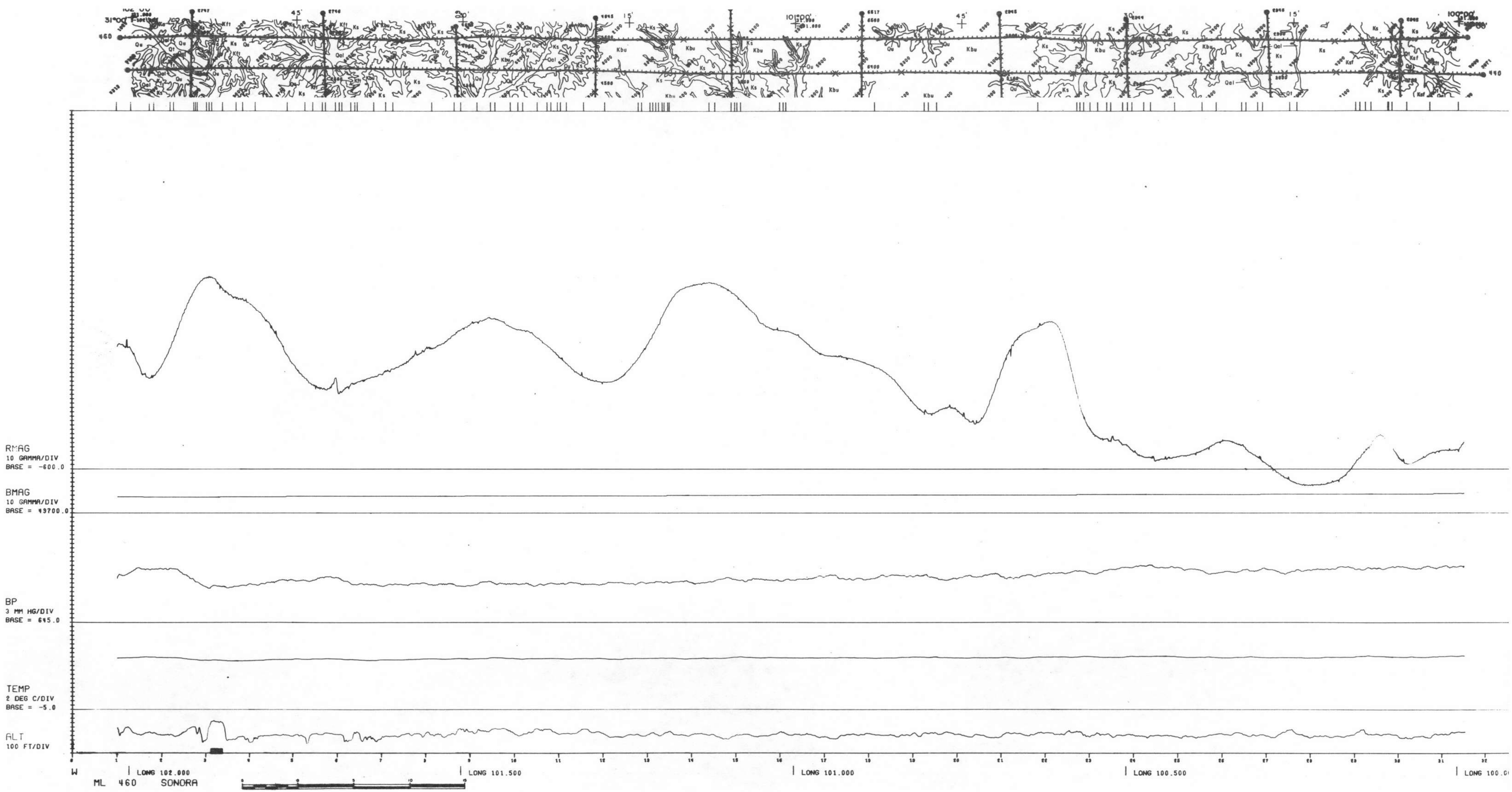
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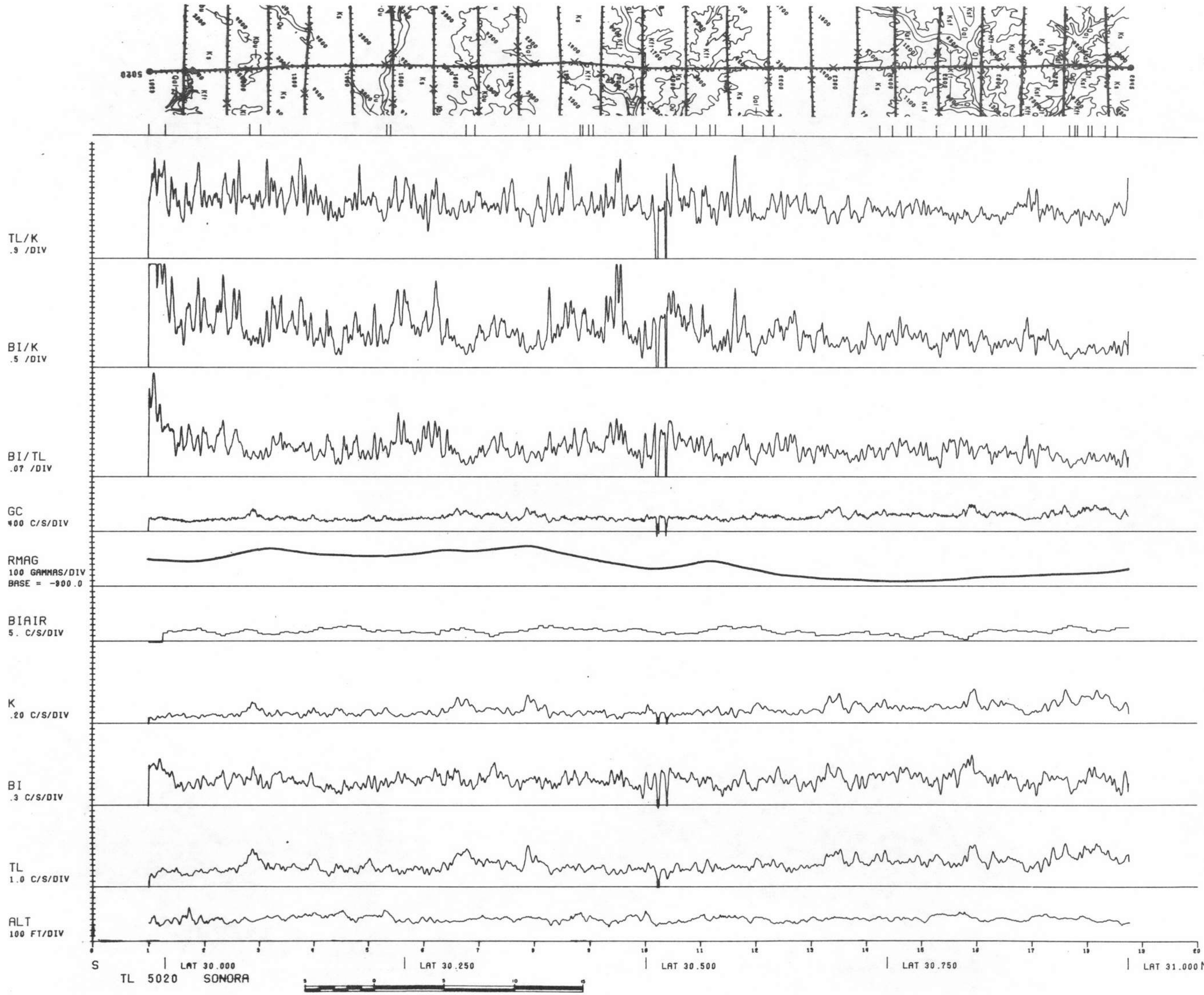
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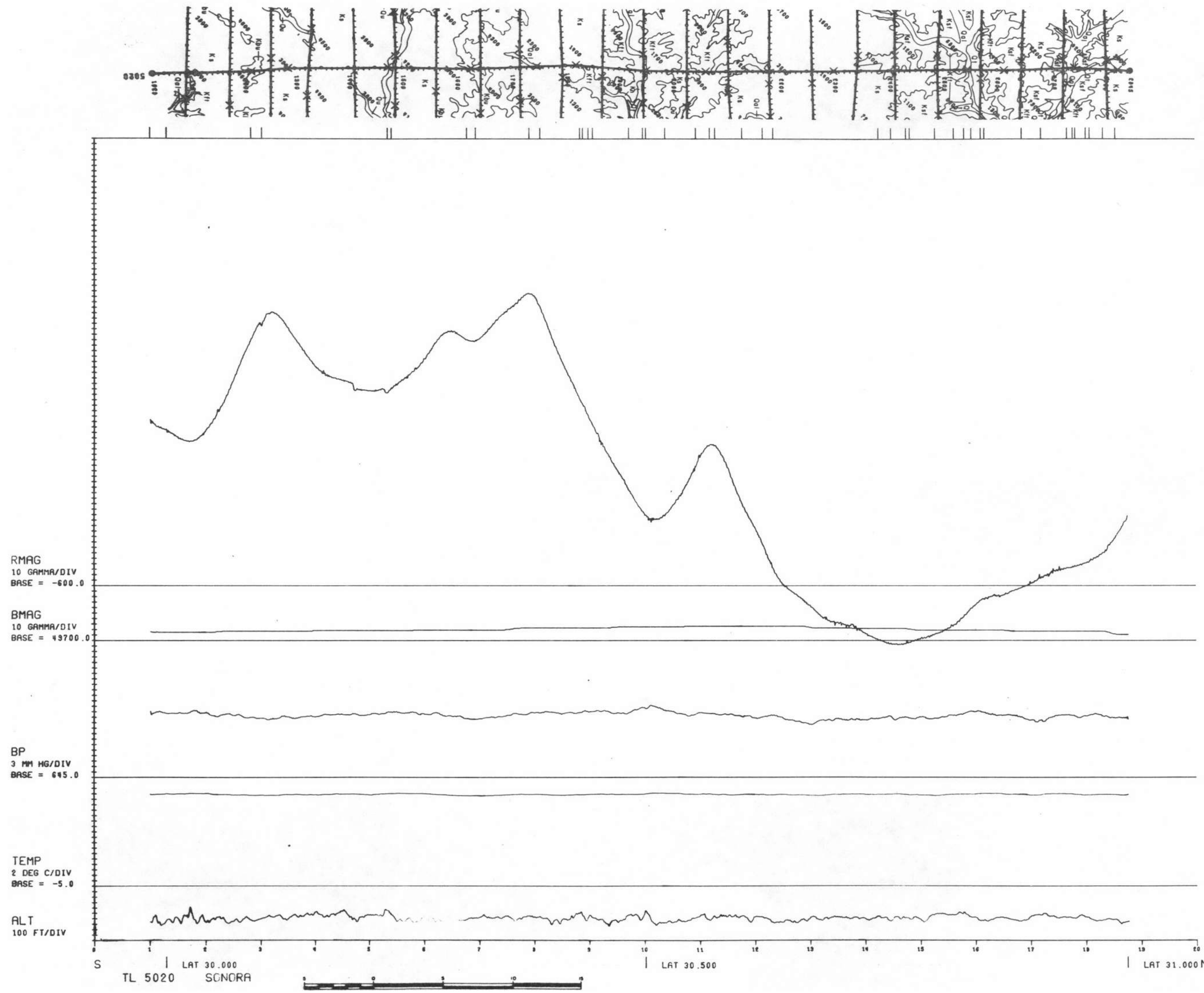
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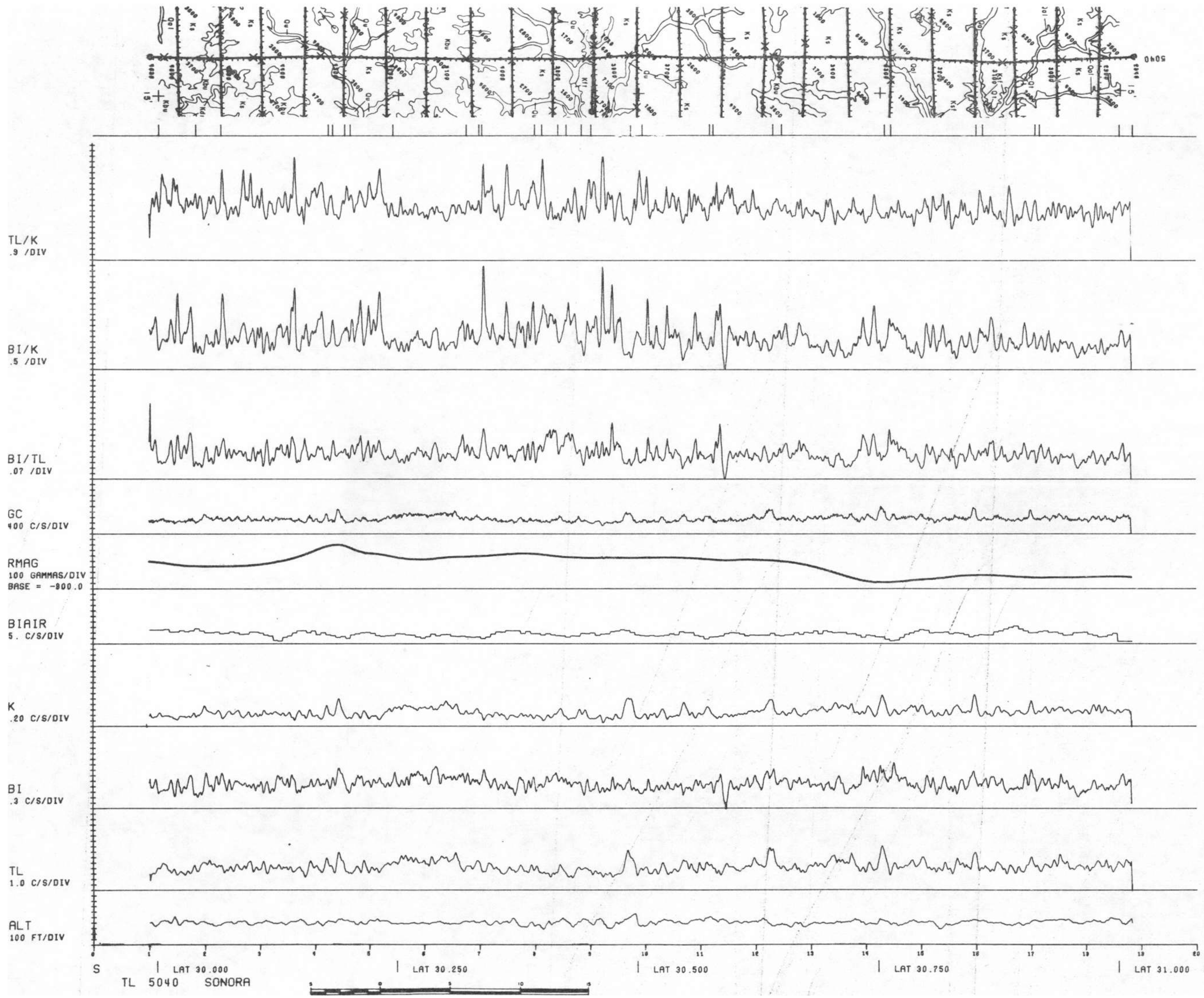
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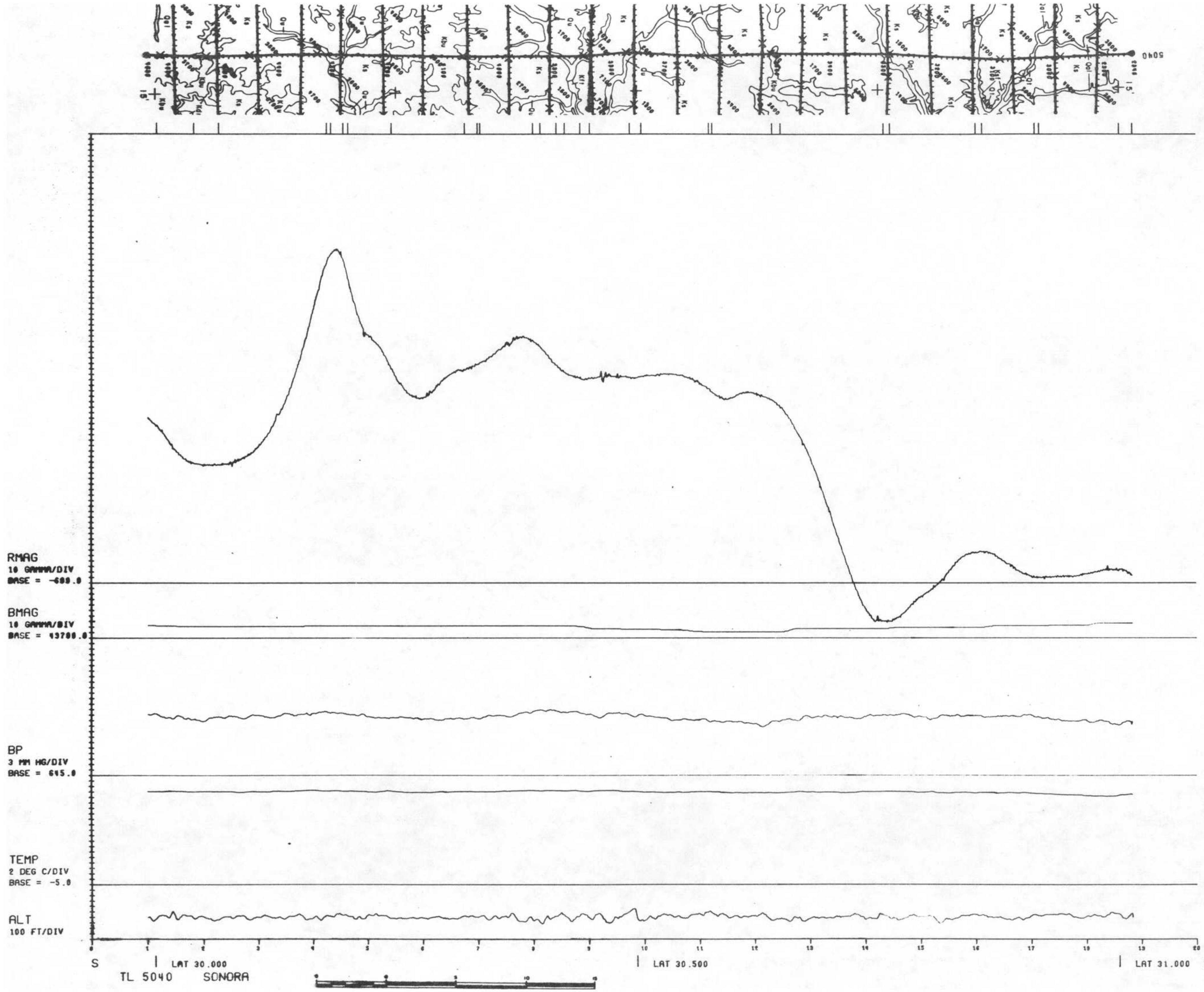

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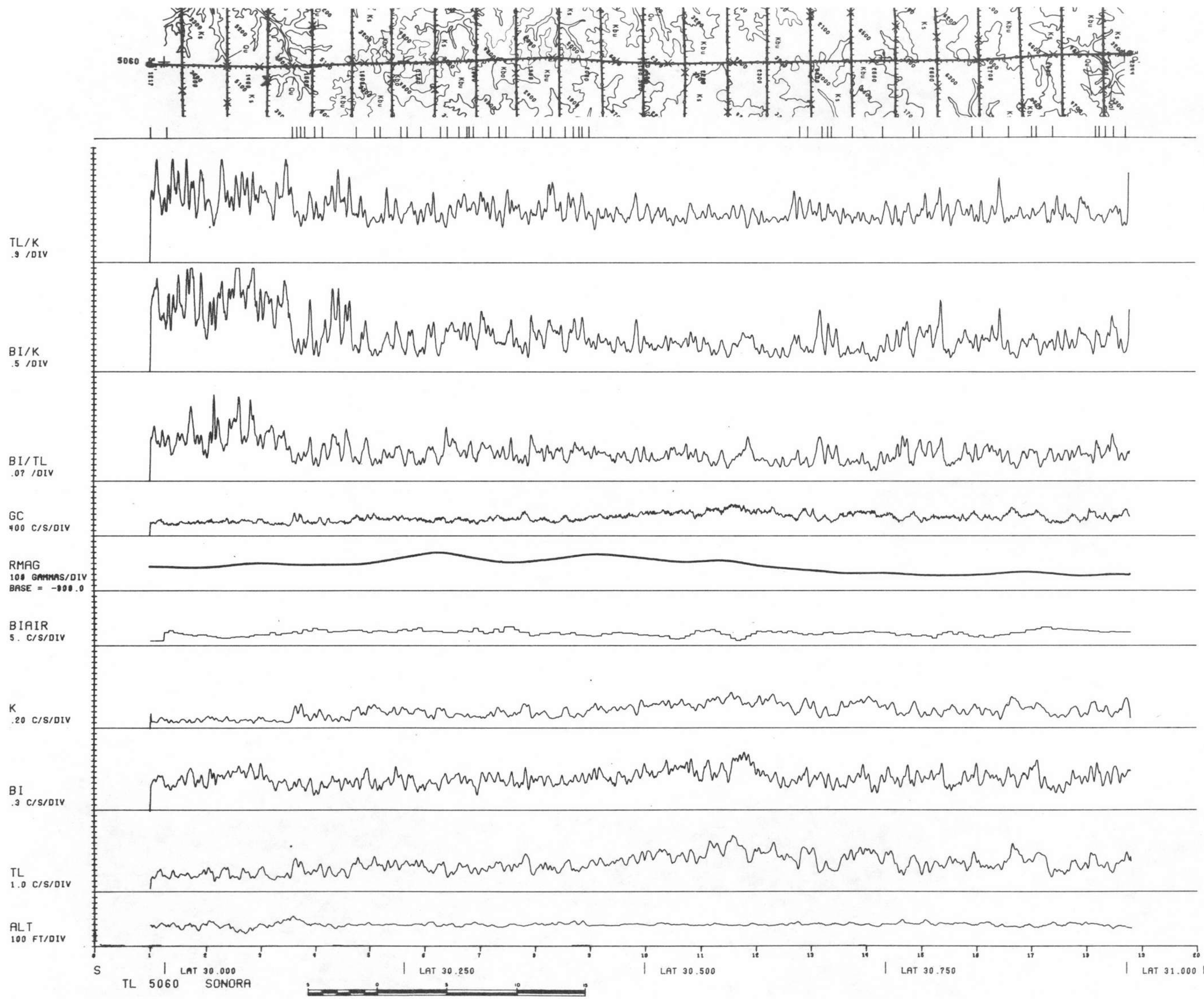
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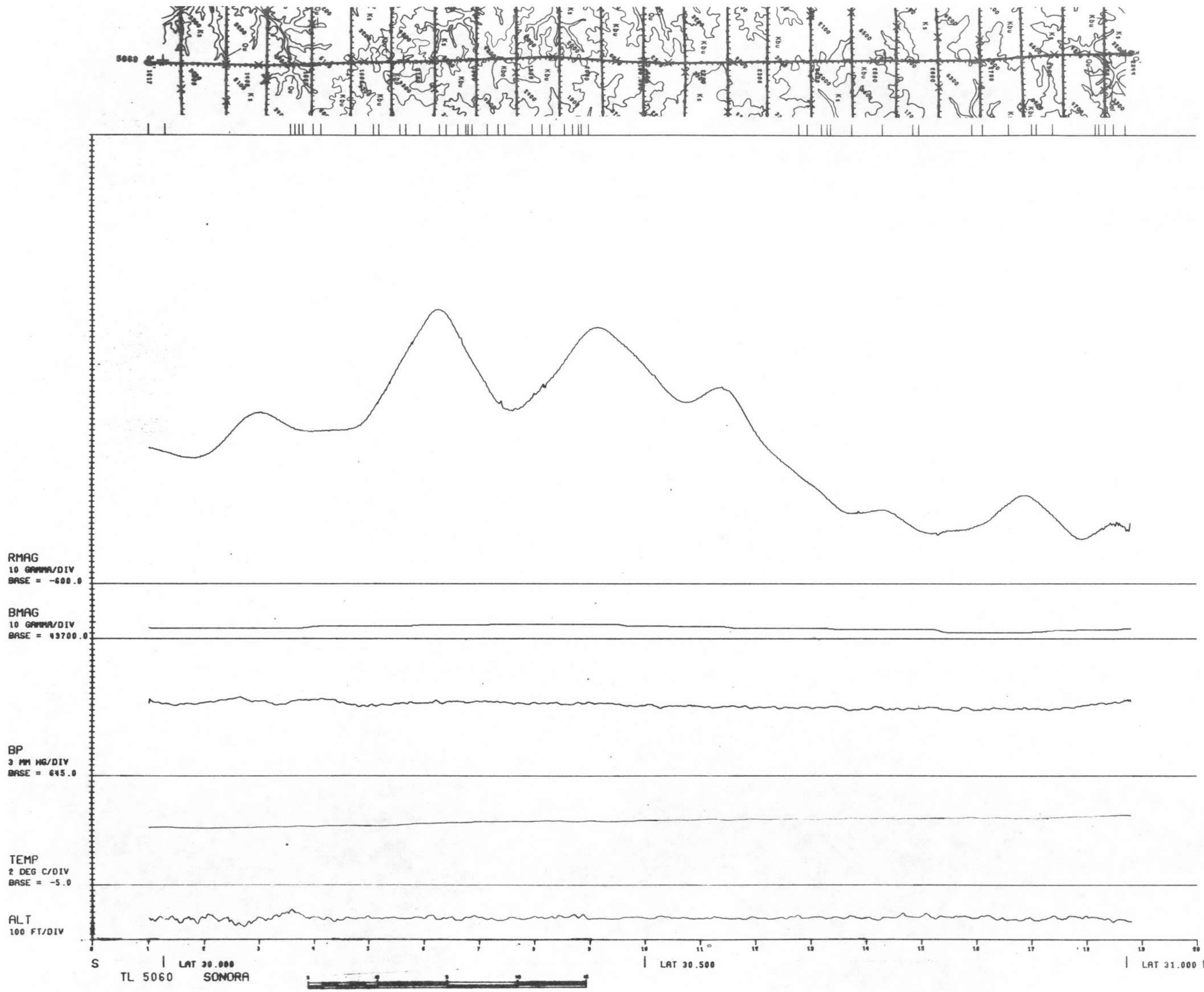

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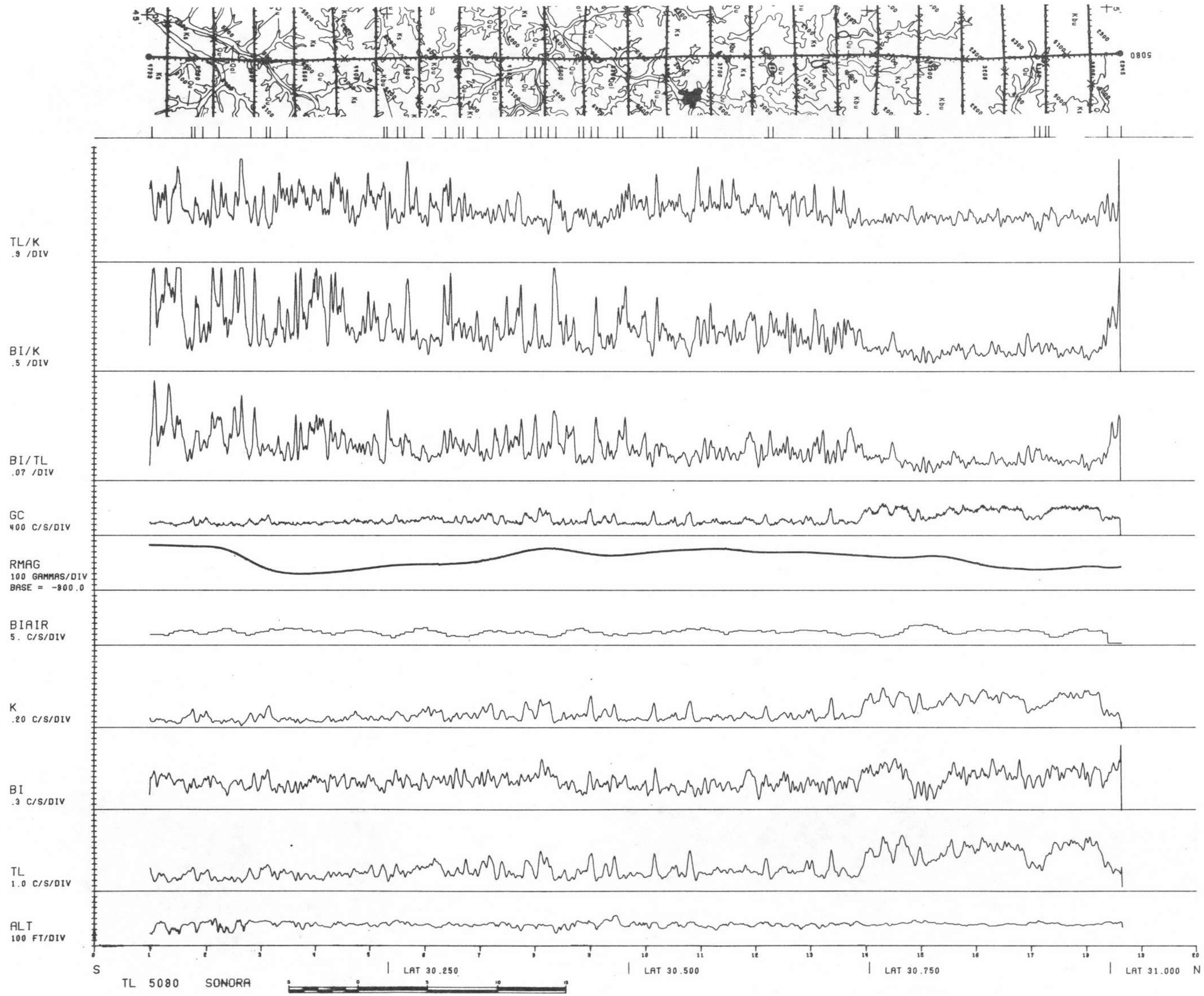

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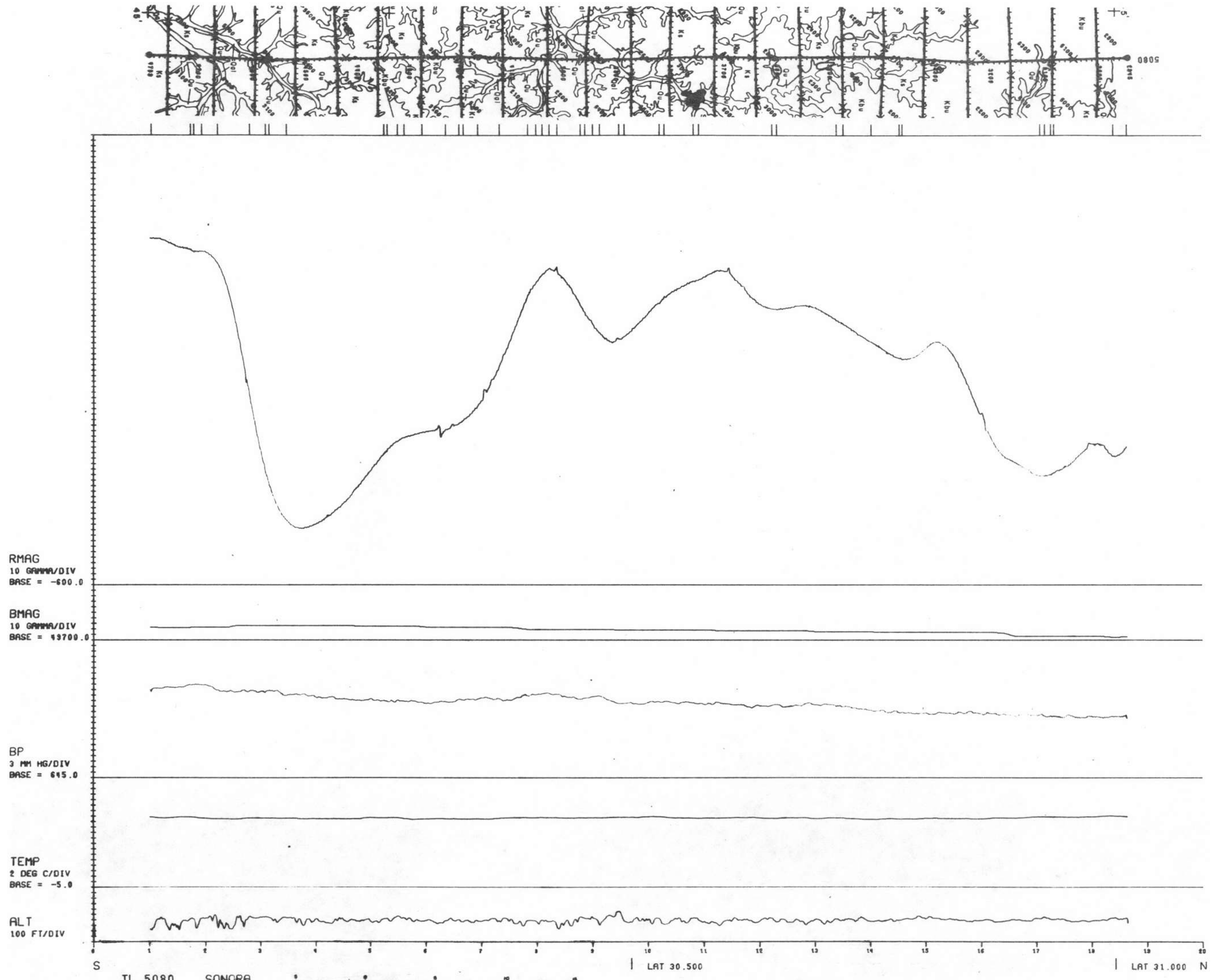
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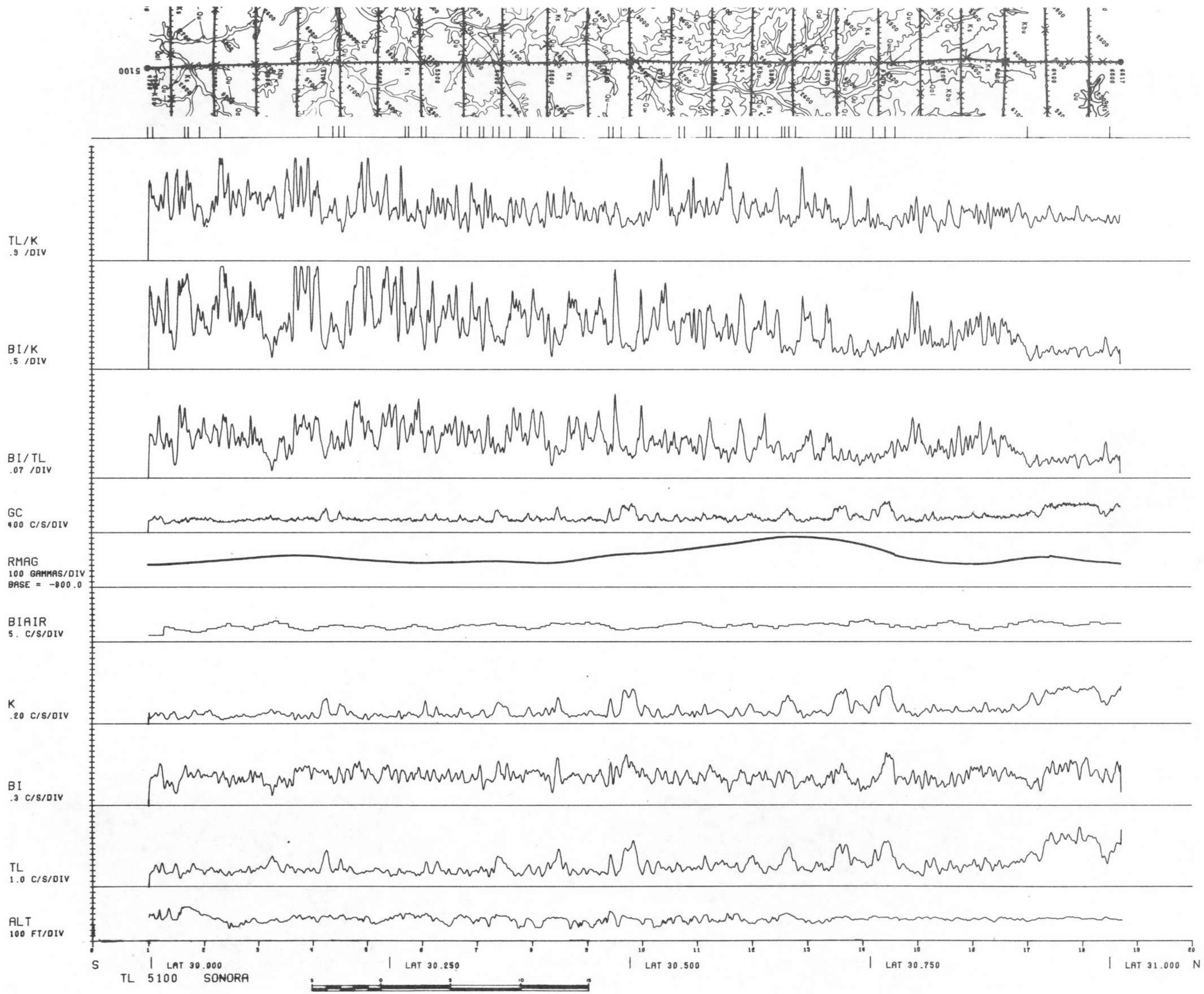
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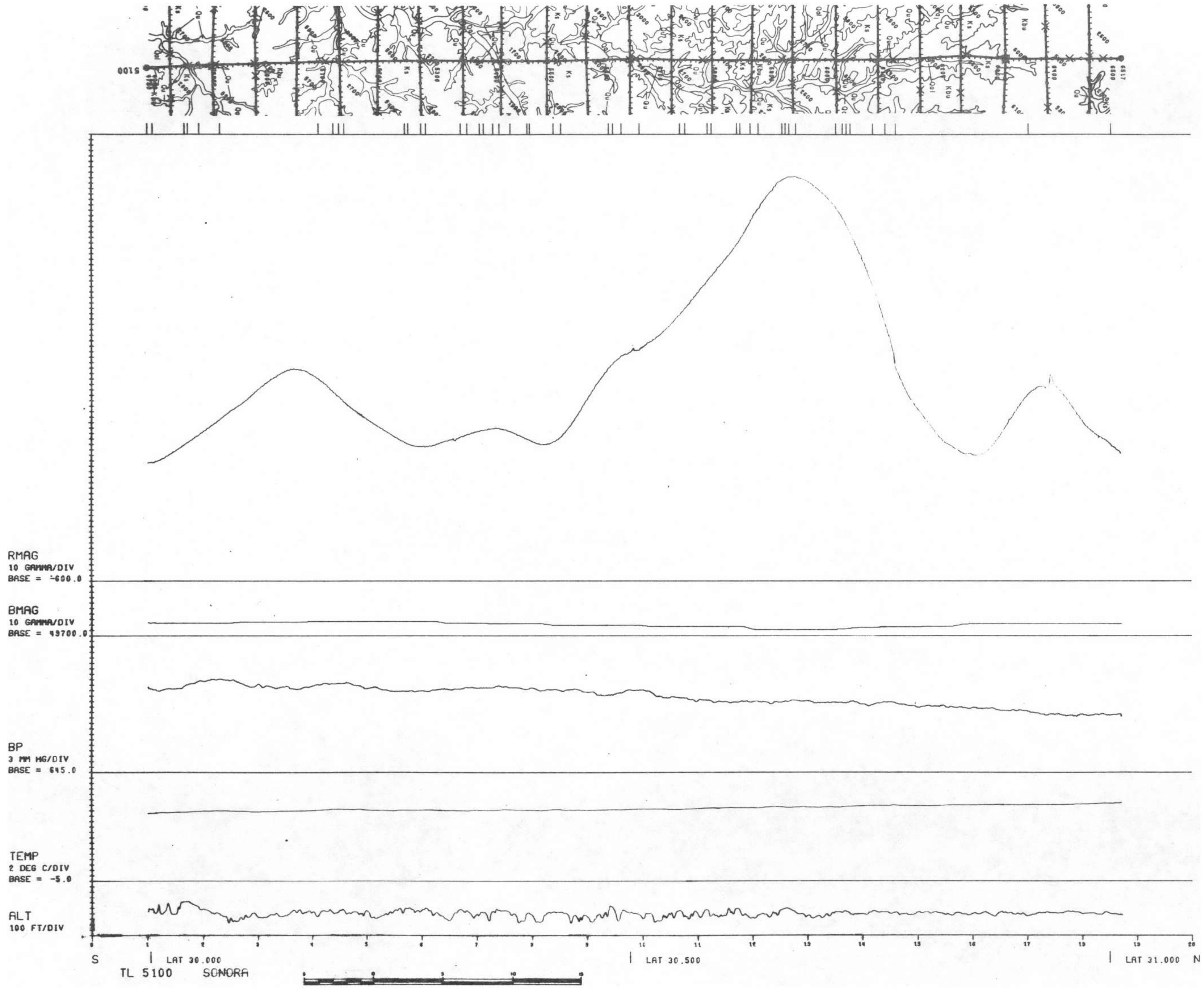
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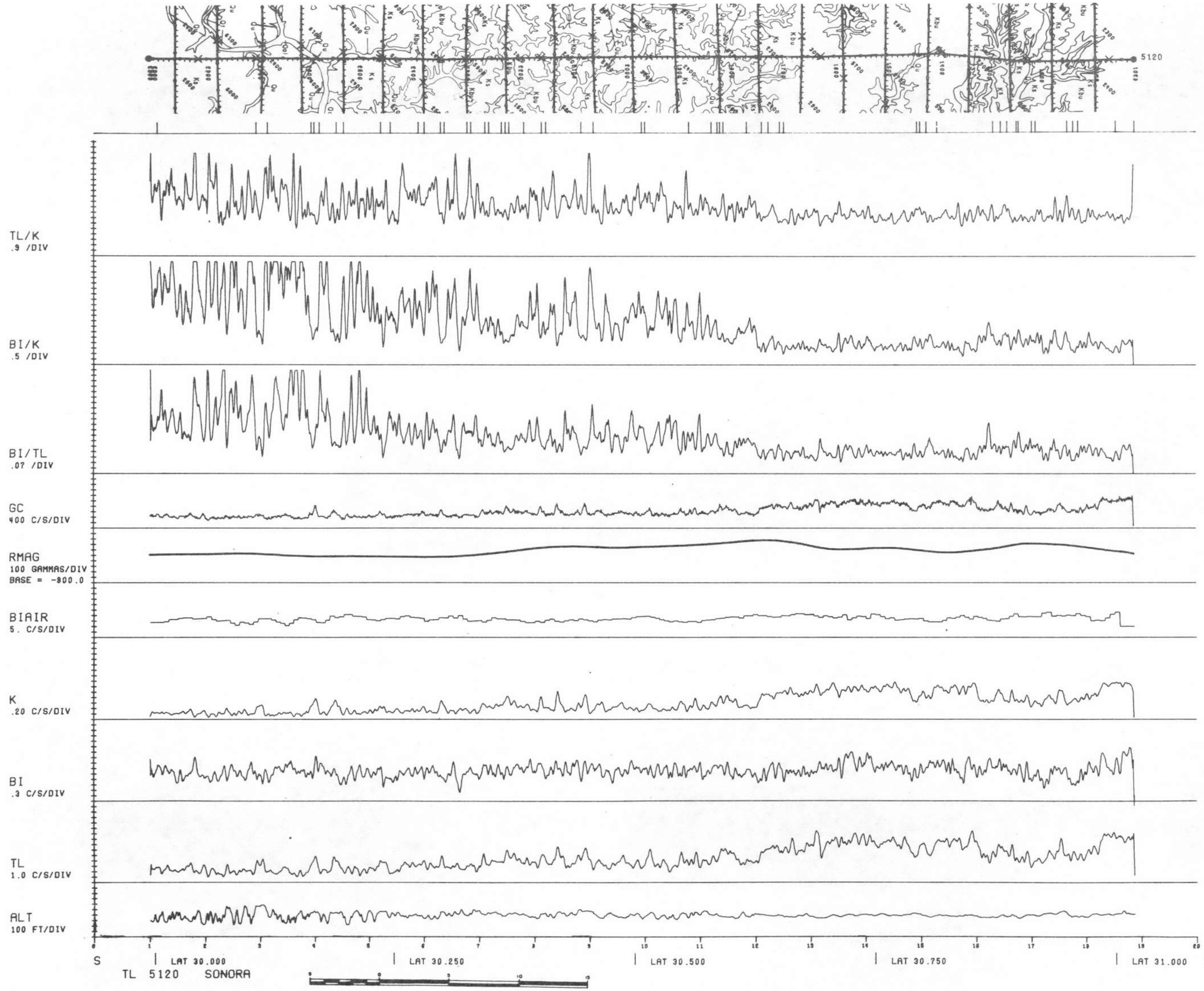

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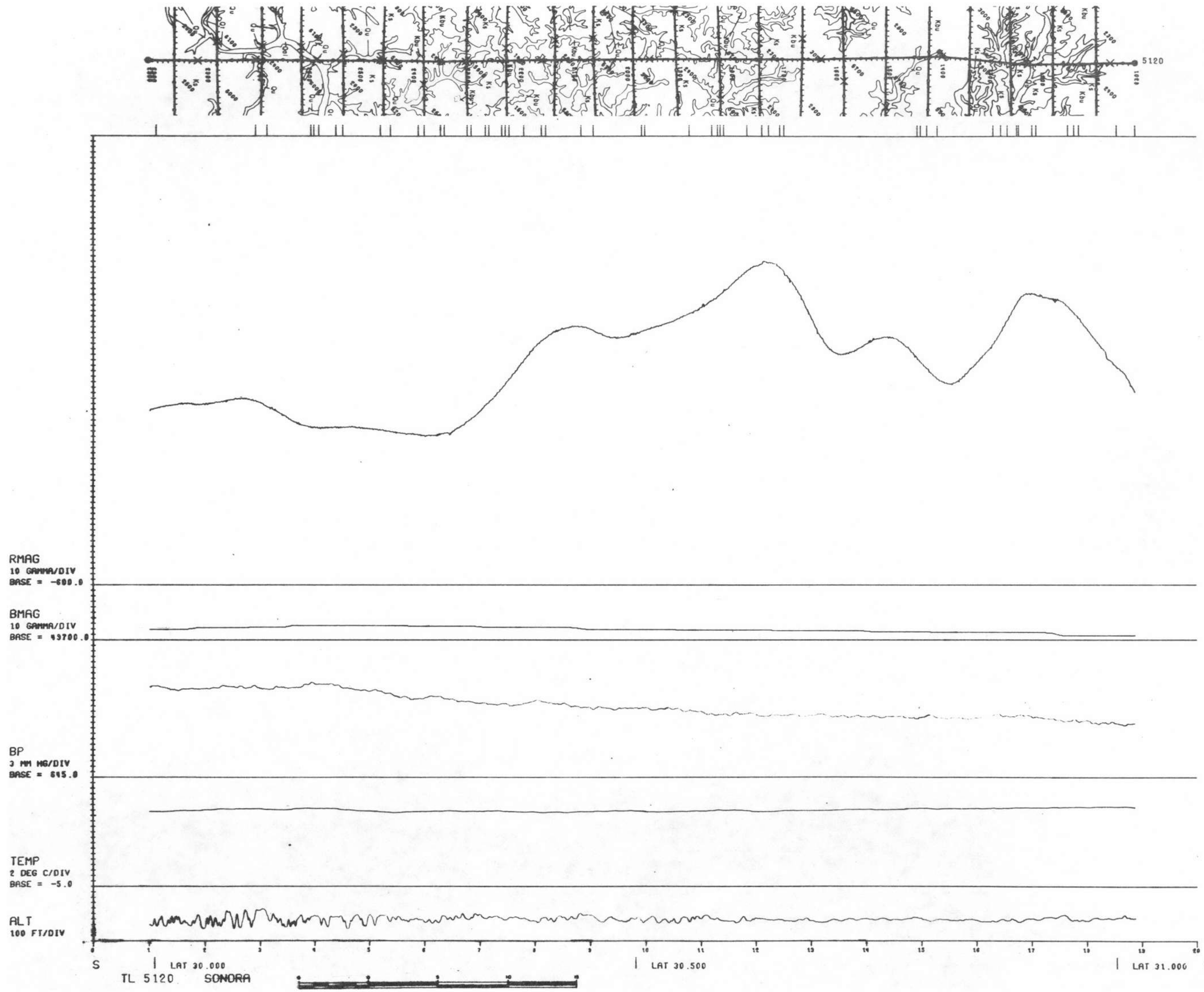
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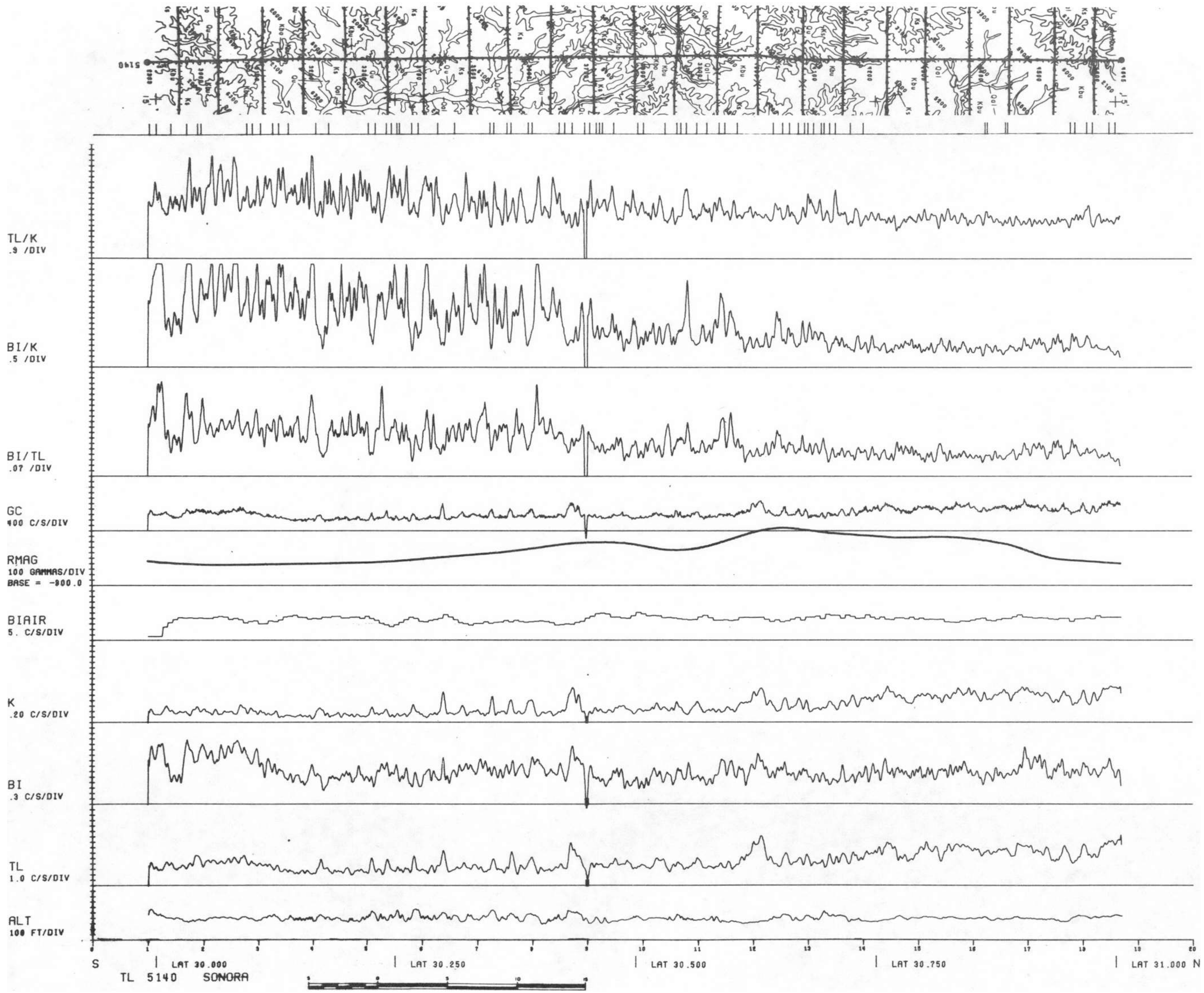
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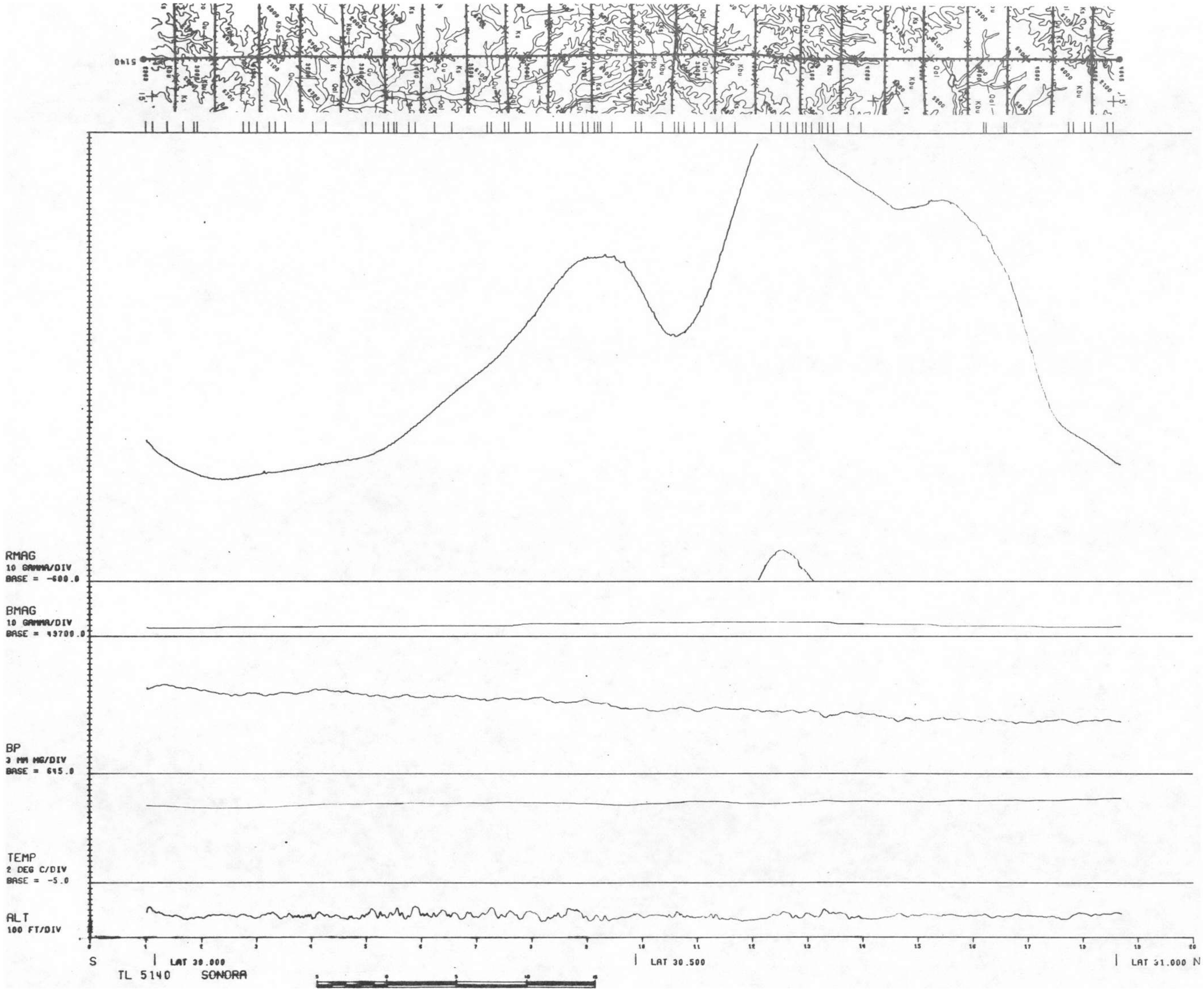
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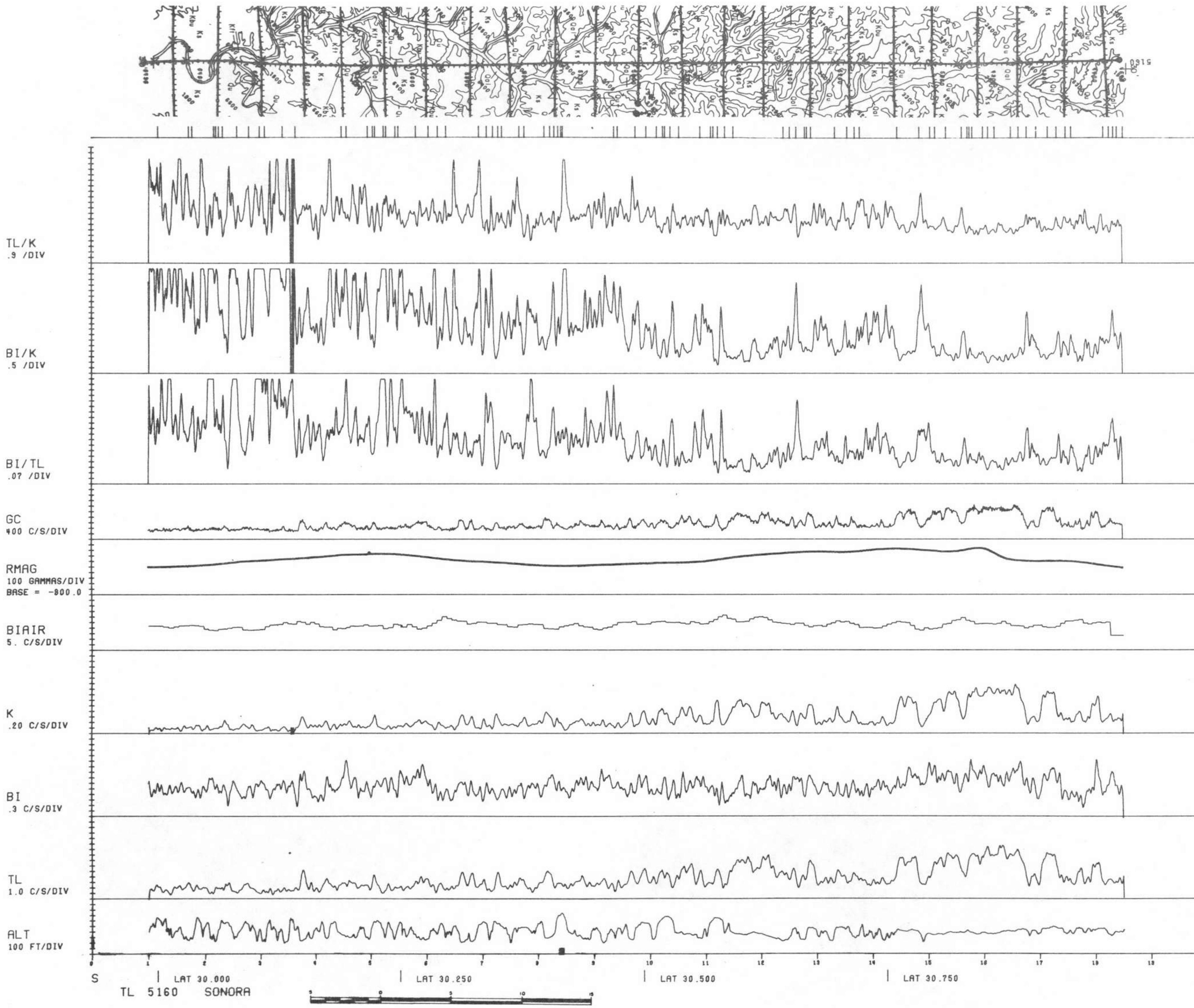

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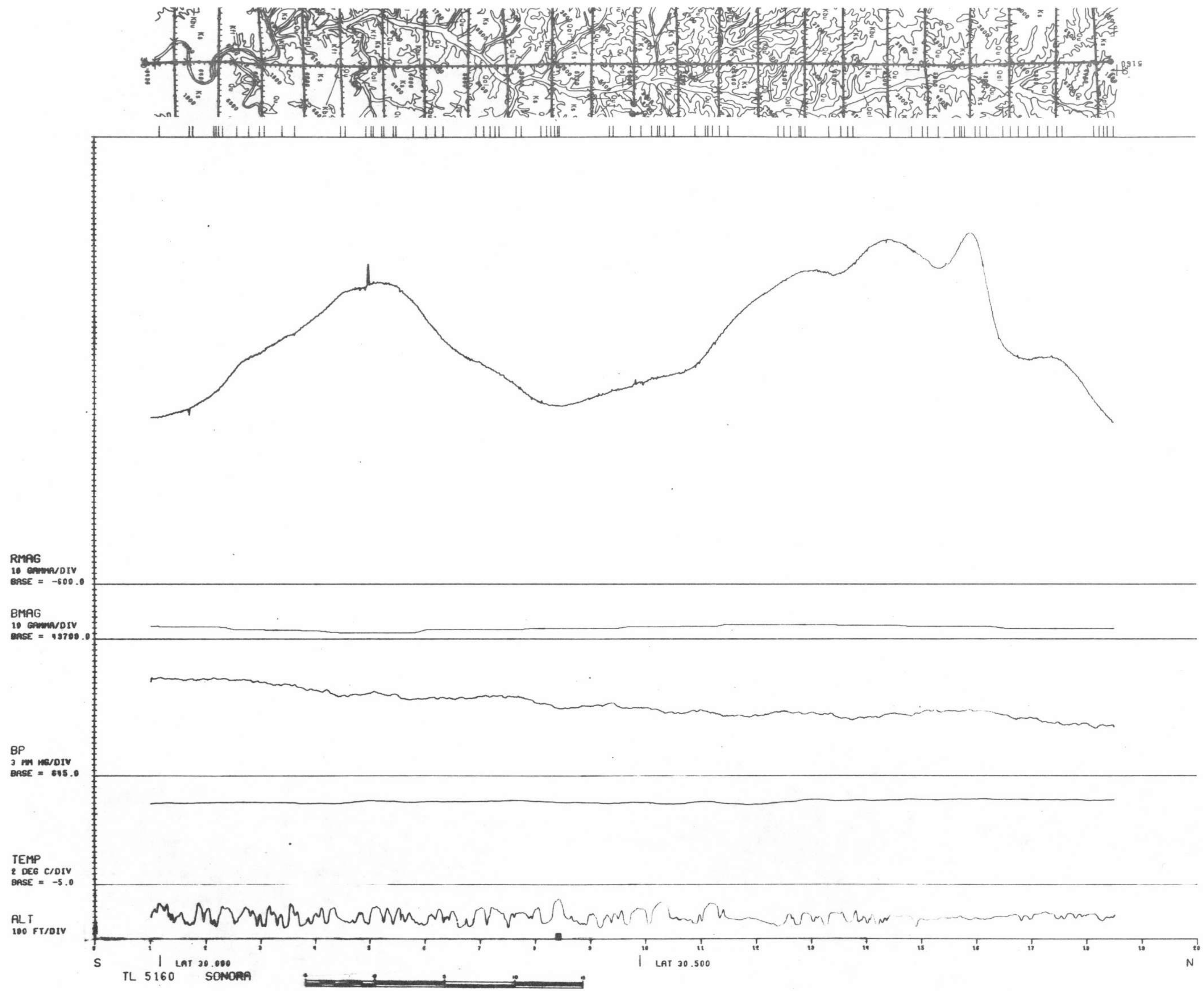
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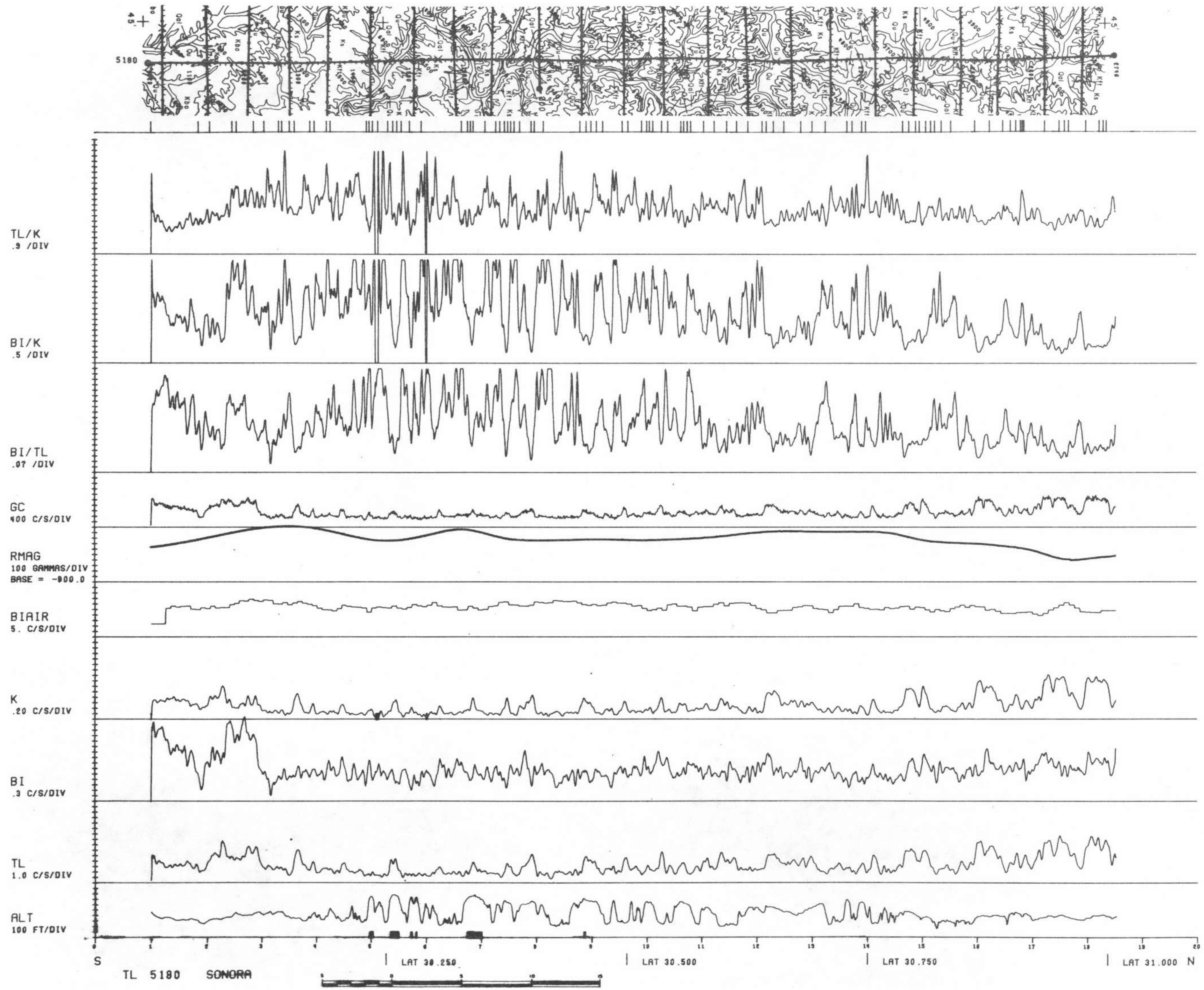
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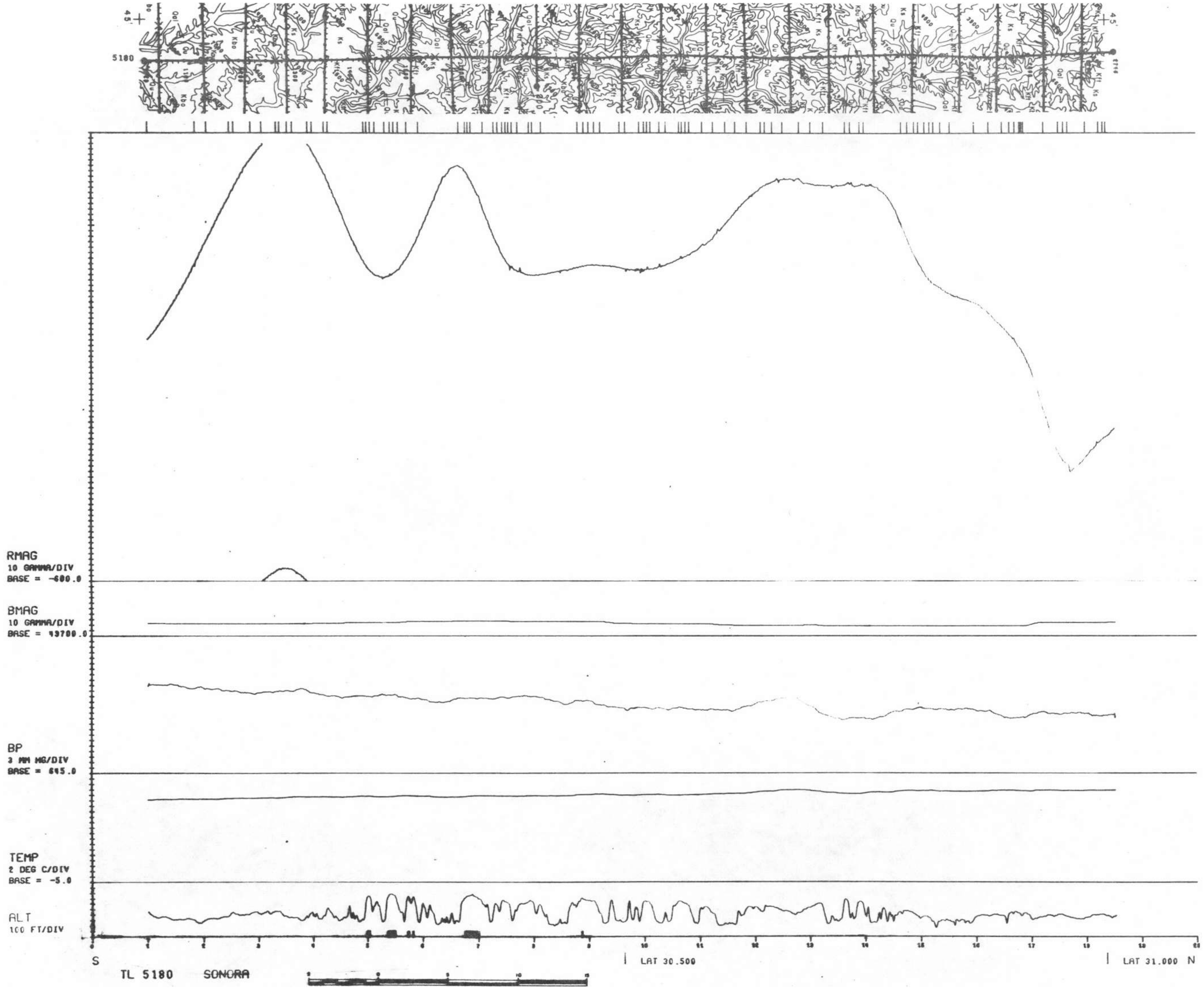

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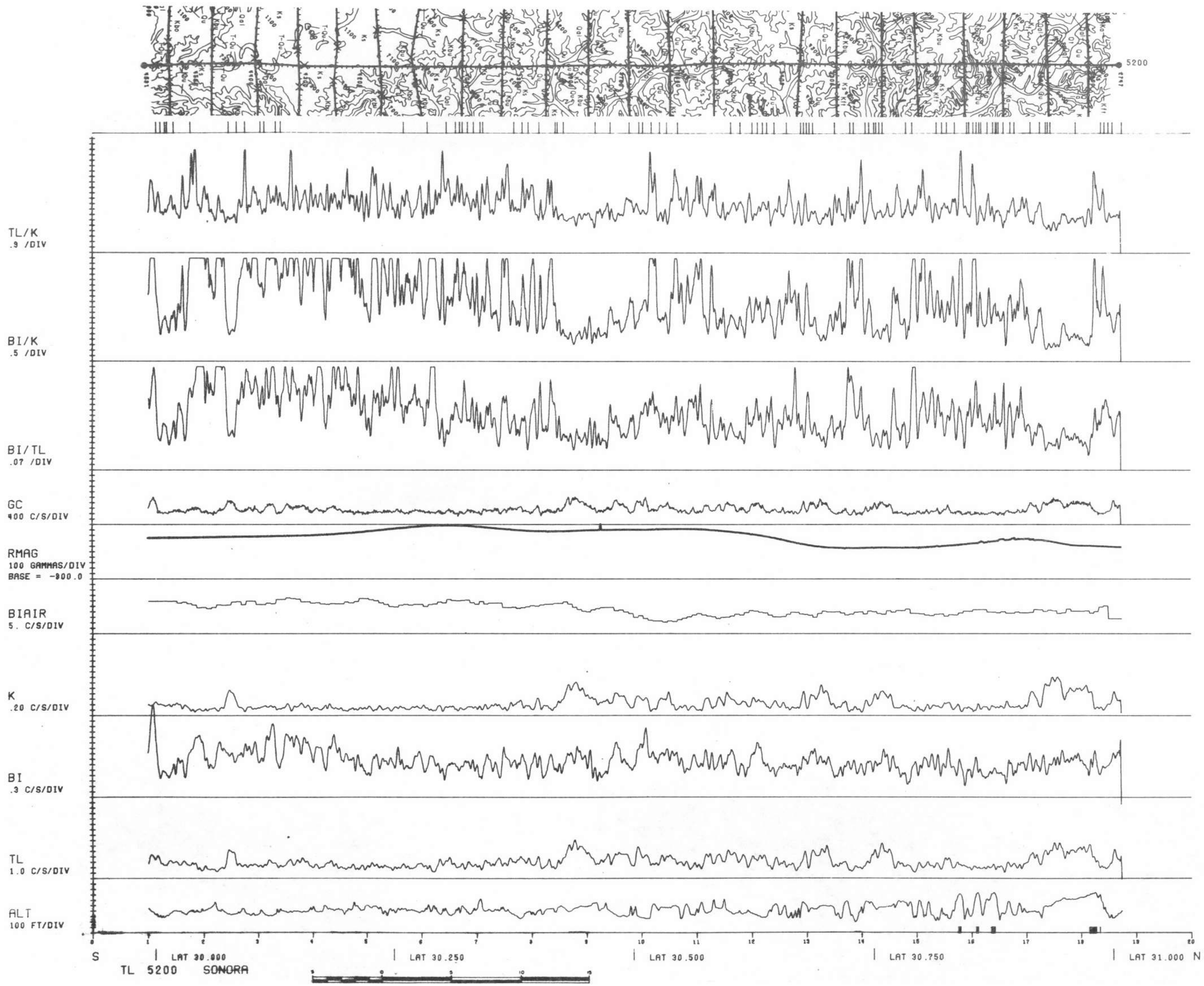

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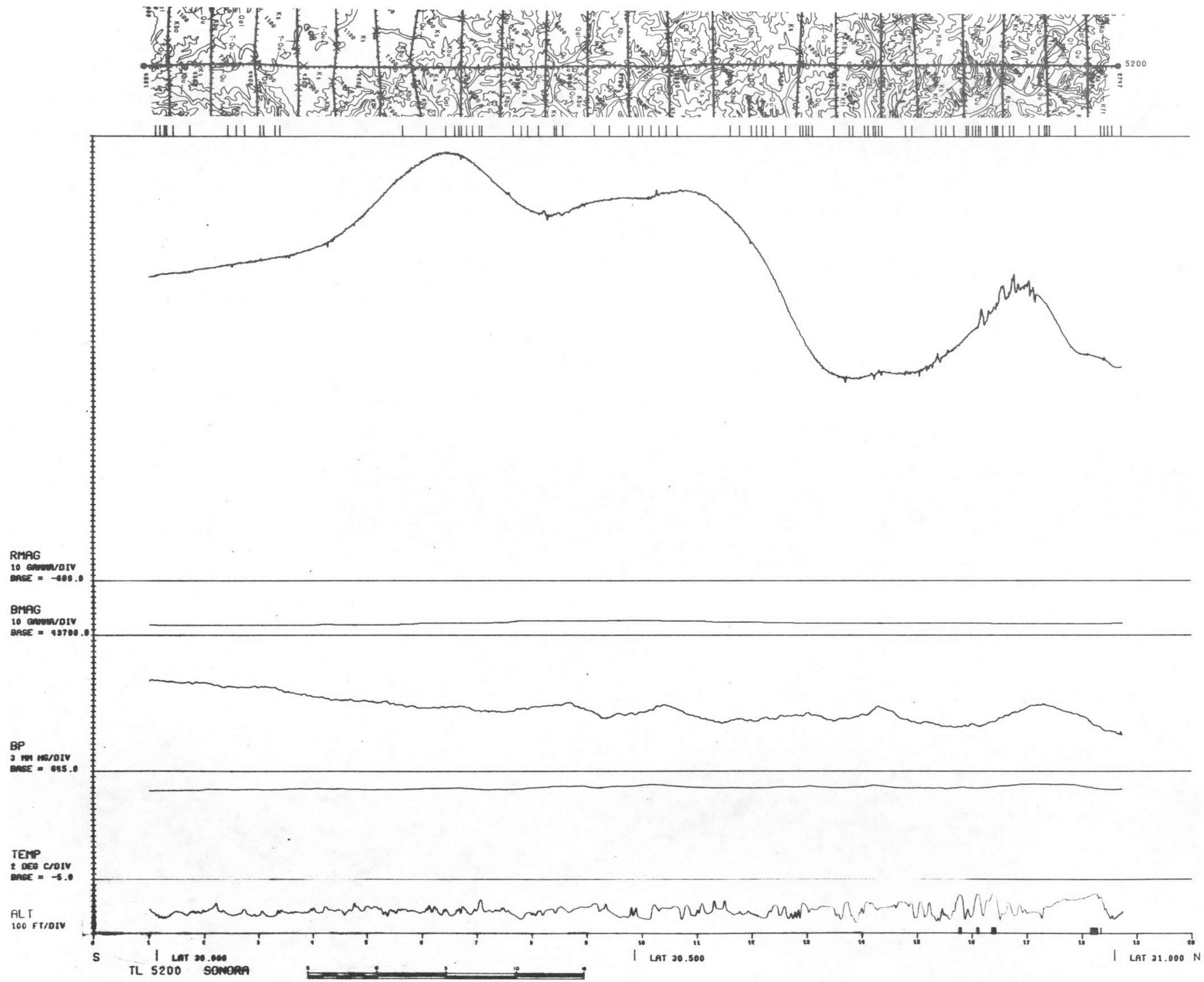
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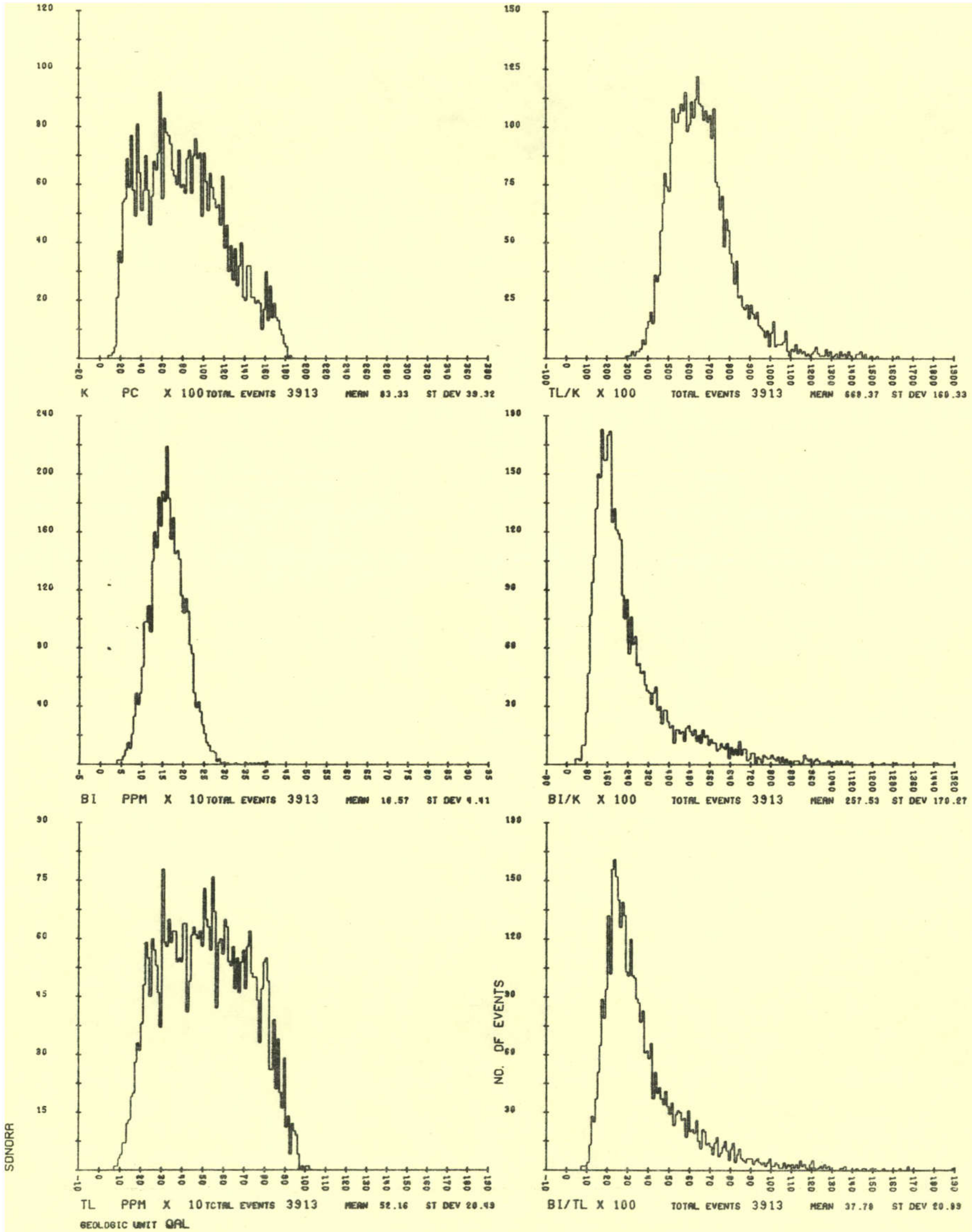
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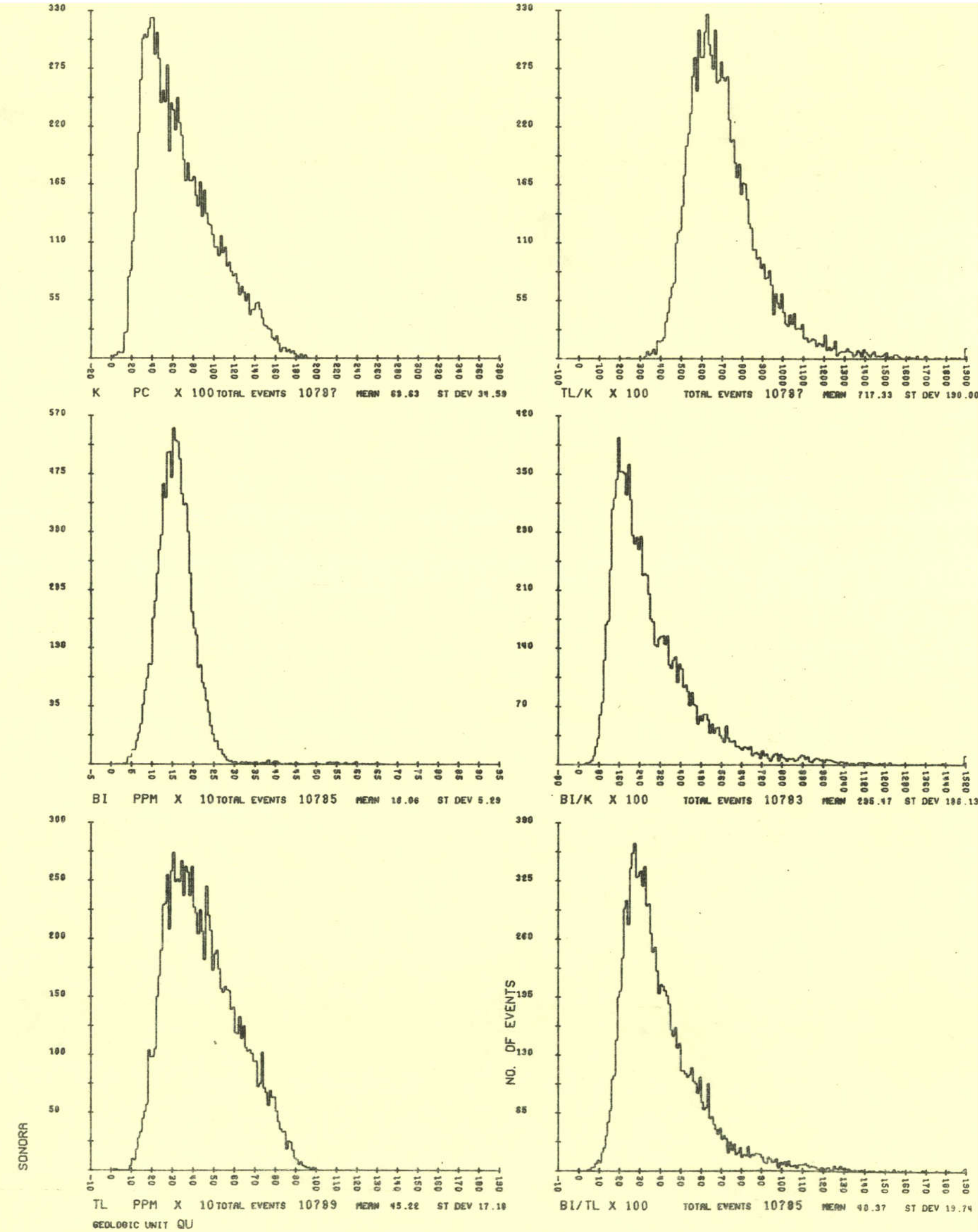
A1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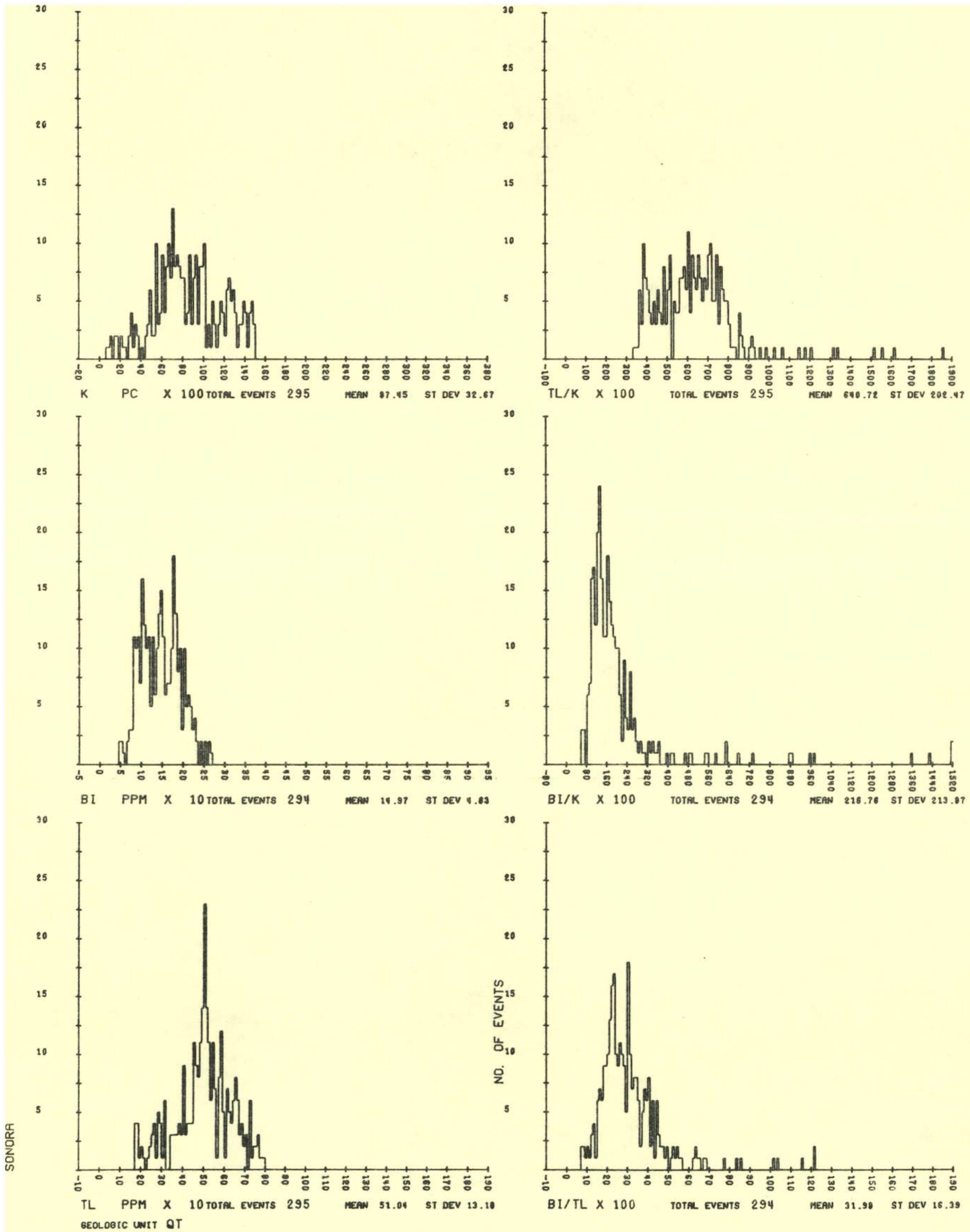
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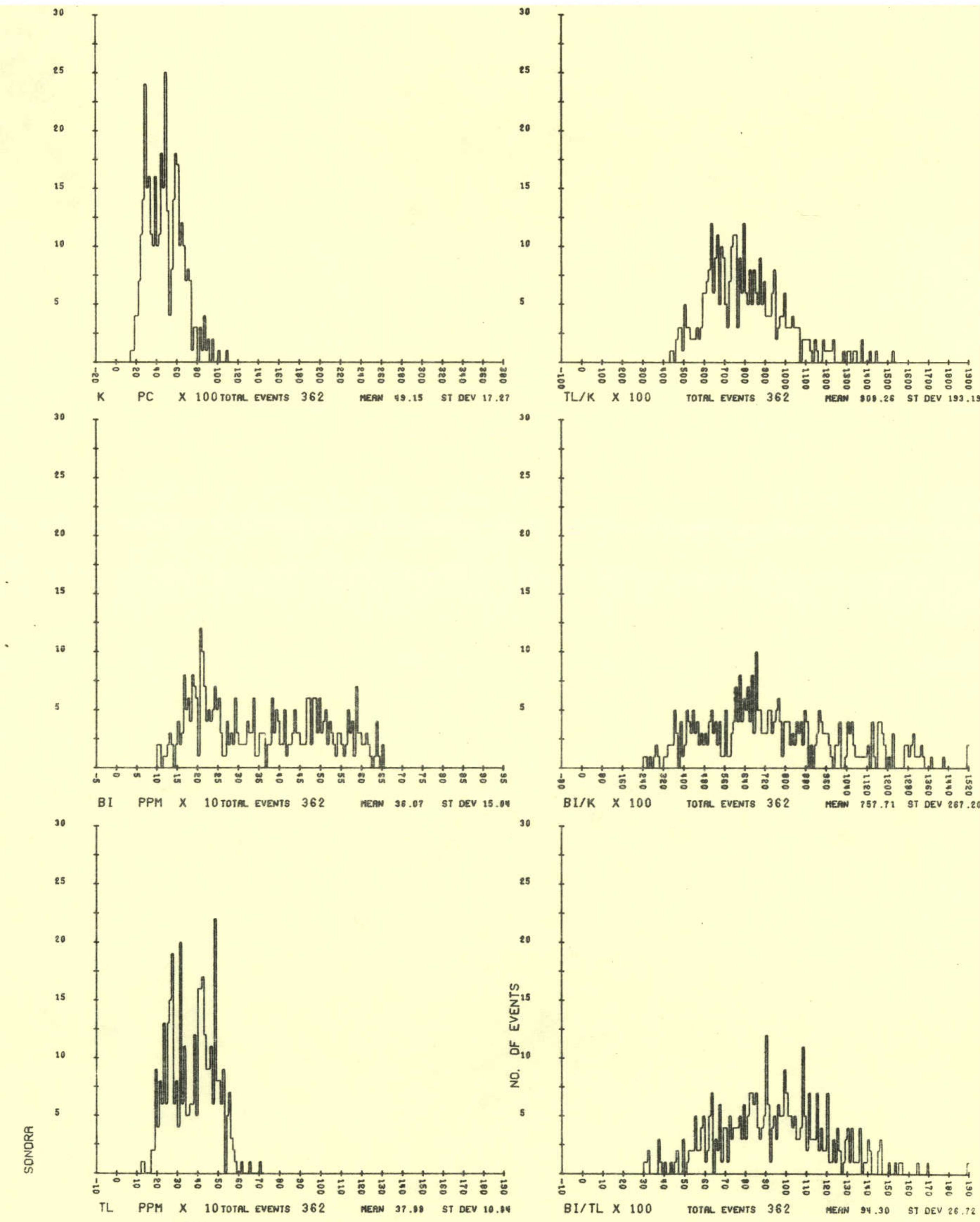
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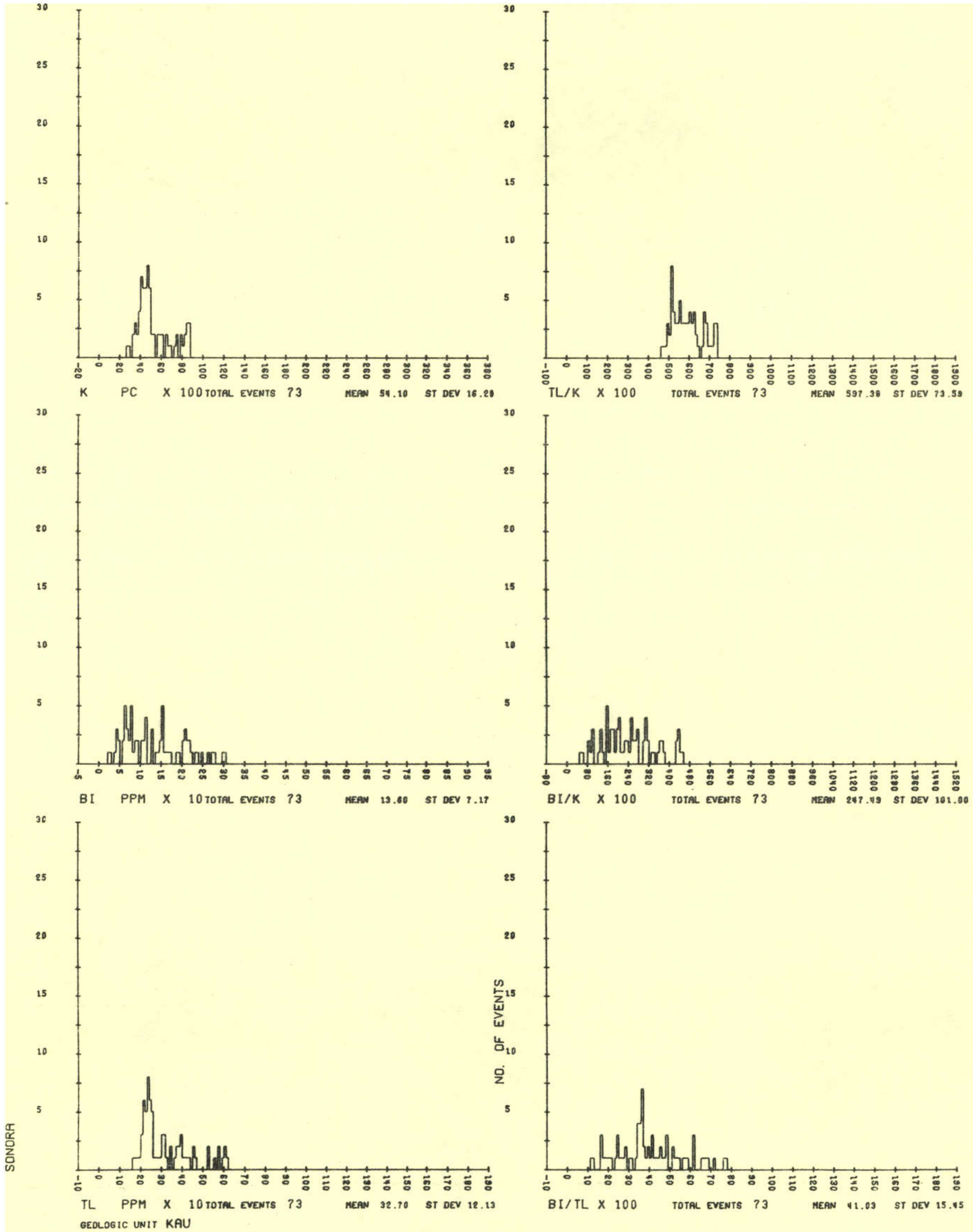
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BI PPM X 10 TOTAL EVENTS 73 MEAN 13.60 ST DEV 7.17
BI/K X 100 TOTAL EVENTS 73 MEAN 247.49 ST DEV 101.00
TL PPM X 10 TOTAL EVENTS 73 MEAN 32.70 ST DEV 12.13
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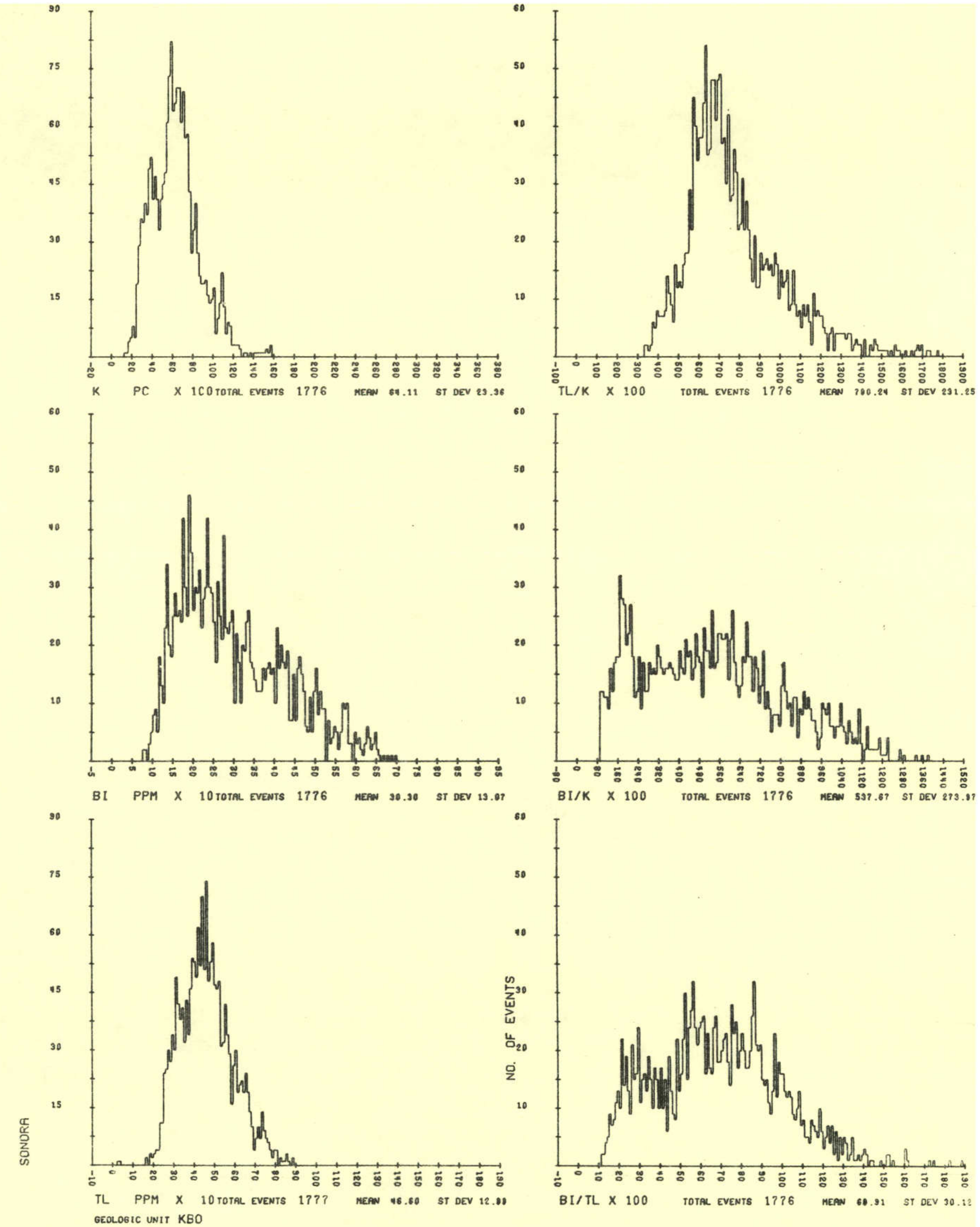
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BI/K X 100 TOTAL EVENTS 1776 MEAN 537.67 ST DEV 273.97
TL PPM X 10 TOTAL EVENTS 1777 MEAN 46.60 ST DEV 12.89
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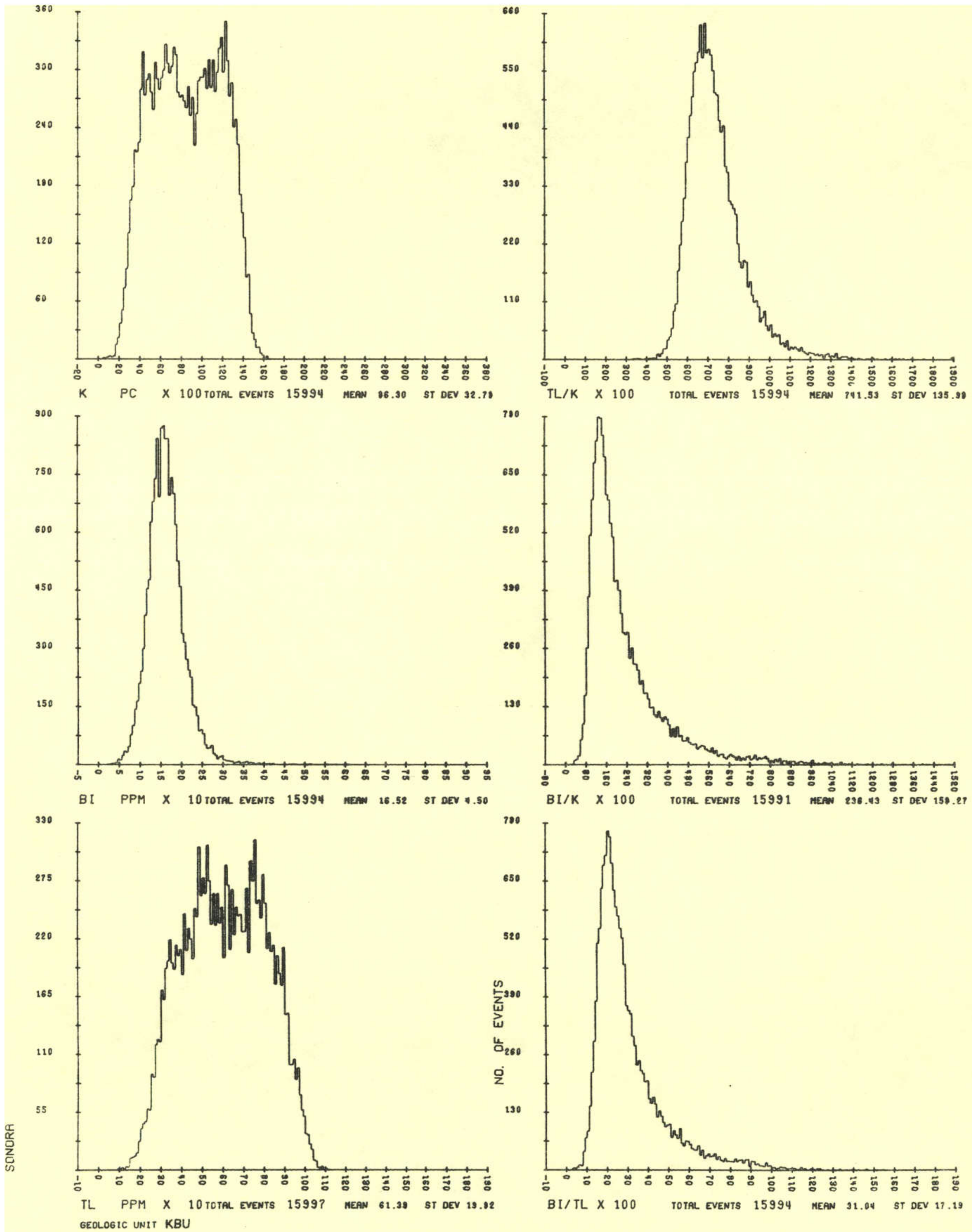

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BI PPM X 10 TOTAL EVENTS 15994 MEAN 16.52 ST DEV 4.50
BI/K X 100 TOTAL EVENTS 15991 MEAN 236.43 ST DEV 159.27
TL PPM X 10 TOTAL EVENTS 15997 MEAN 61.39 ST DEV 19.92
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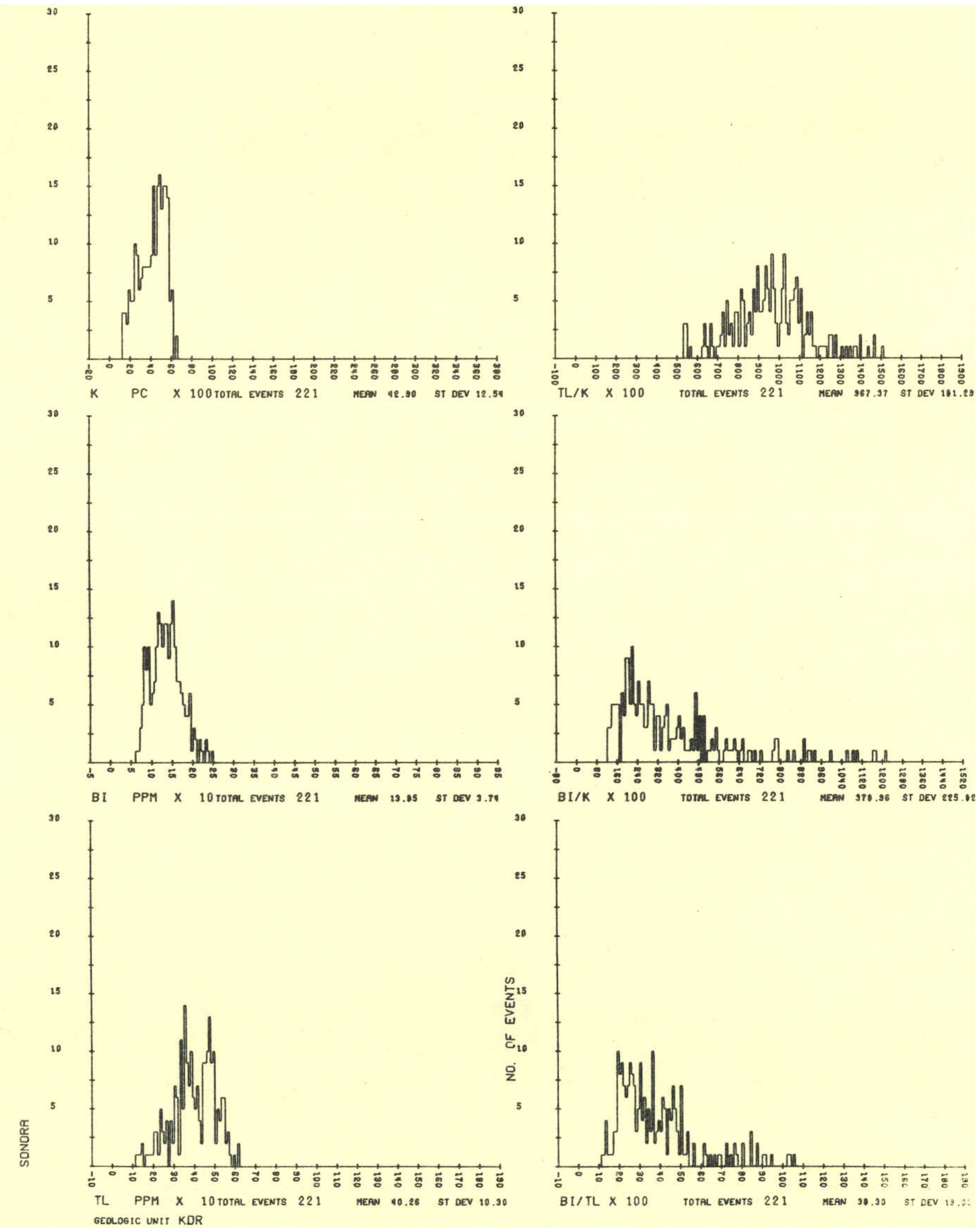

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BI/K X 100 TOTAL EVENTS 221 MEAN 370.96 ST DEV 225.92
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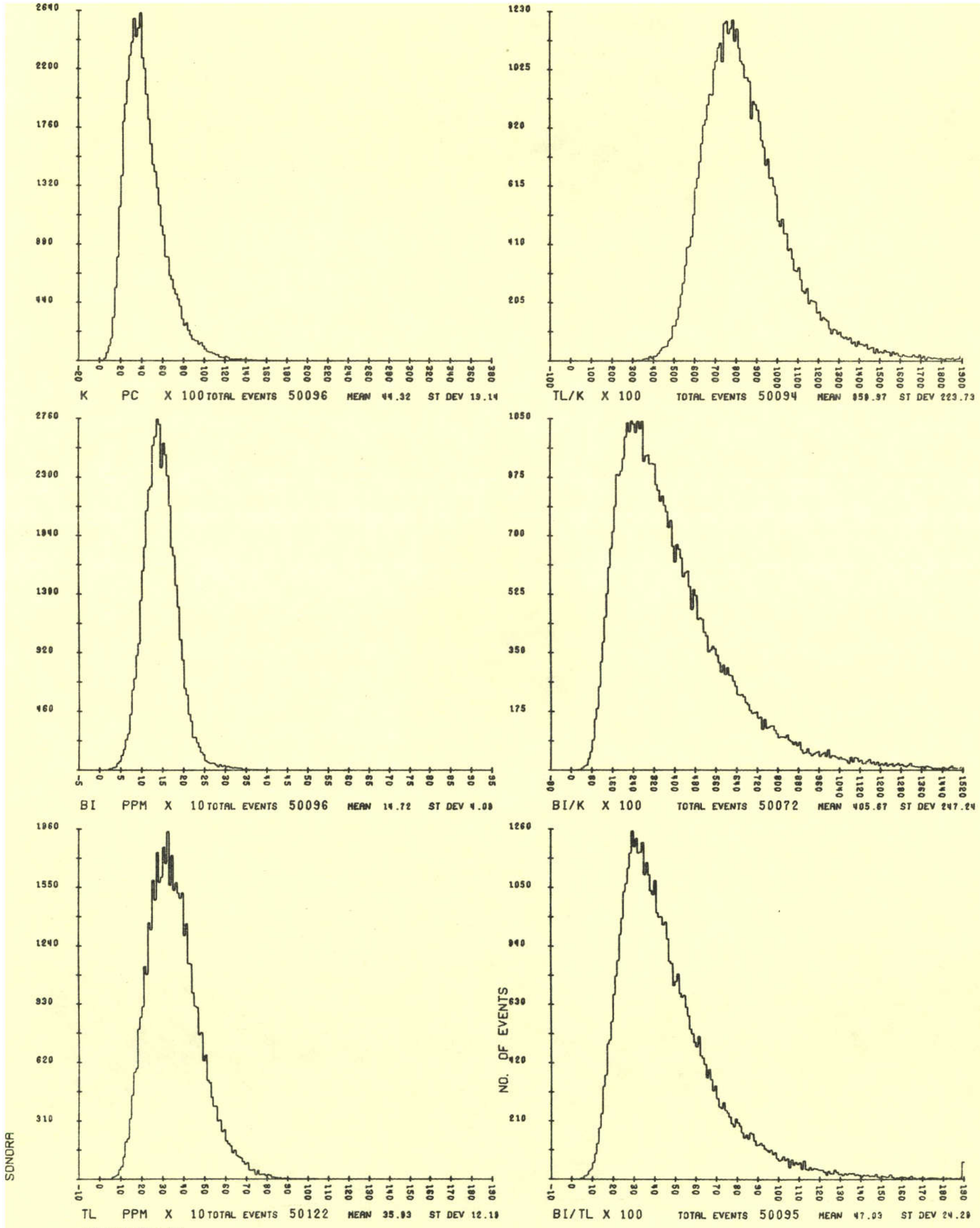
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BI/K X 100 TOTAL EVENTS 50072 MEAN 405.67 ST DEV 247.24
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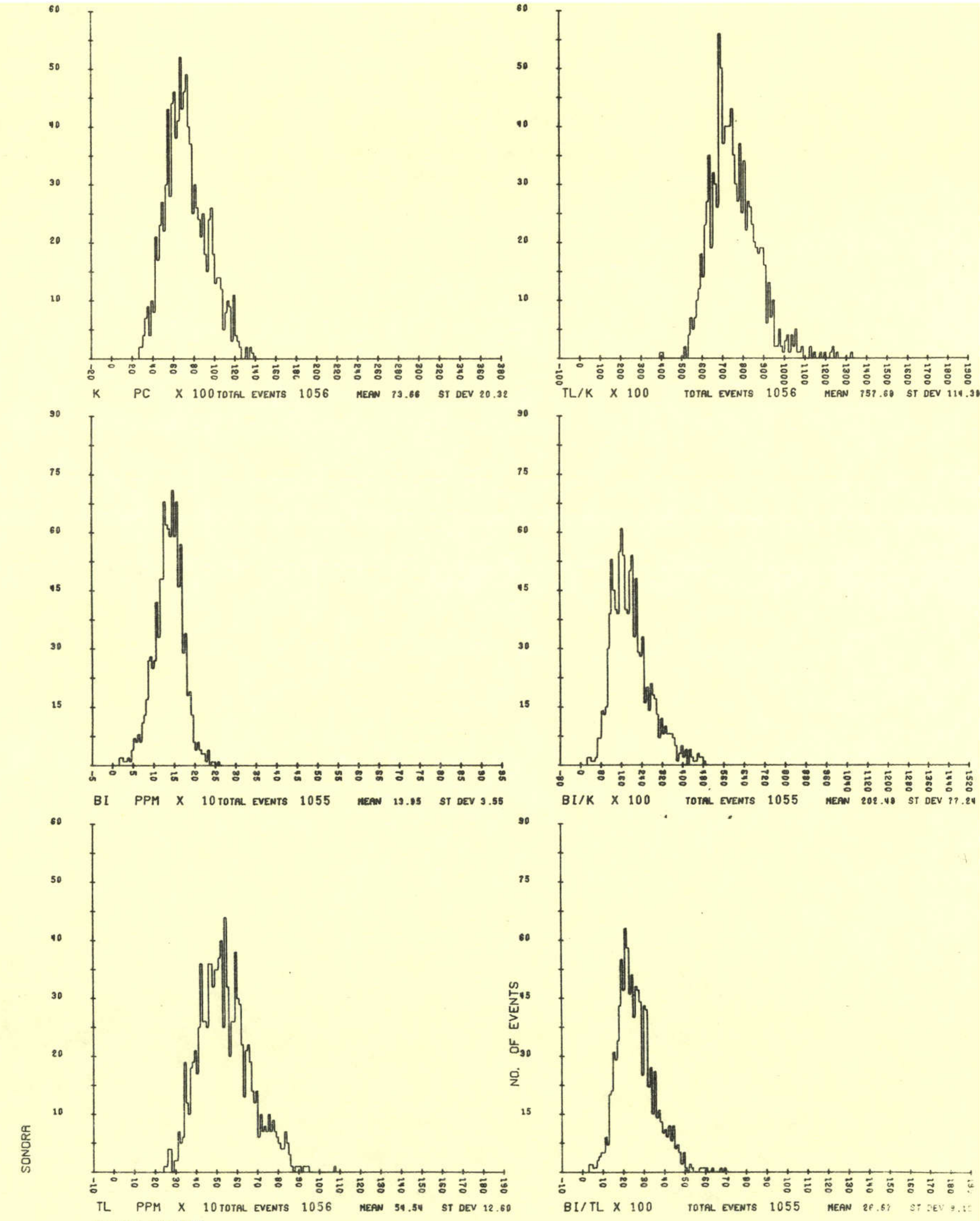
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TL/K X 100 TOTAL EVENTS 1056 MEAN 757.69 ST DEV 114.38
BI PPM X 10 TOTAL EVENTS 1055 MEAN 13.95 ST DEV 3.55
BI/K X 100 TOTAL EVENTS 1055 MEAN 202.48 ST DEV 77.24
TL PPM X 10 TOTAL EVENTS 1056 MEAN 54.54 ST DEV 12.60
BI/TL X 100 TOTAL EVENTS 1055 MEAN
GEOLOGIC UNIT KSF


SONORA
K PC X 100 TOTAL EVENTS 2718 MEAN 43.27 ST DEV 22.96
TL/K X 100 TOTAL EVENTS 2717 MEAN 777.94 ST DEV 226.93
BI PPM X 10 TOTAL EVENTS 2728 MEAN 14.66 ST DEV 3.90
BI/K X 100 TOTAL EVENTS 2718 MEAN 436.12 ST DEV 277.01
TL PPM X 10 TOTAL EVENTS 2728 MEAN 31.00 ST DEV 12.53
BI/TL X 100 TOTAL EVENTS 2727 MEAN 55.96 ST DEV 29.57
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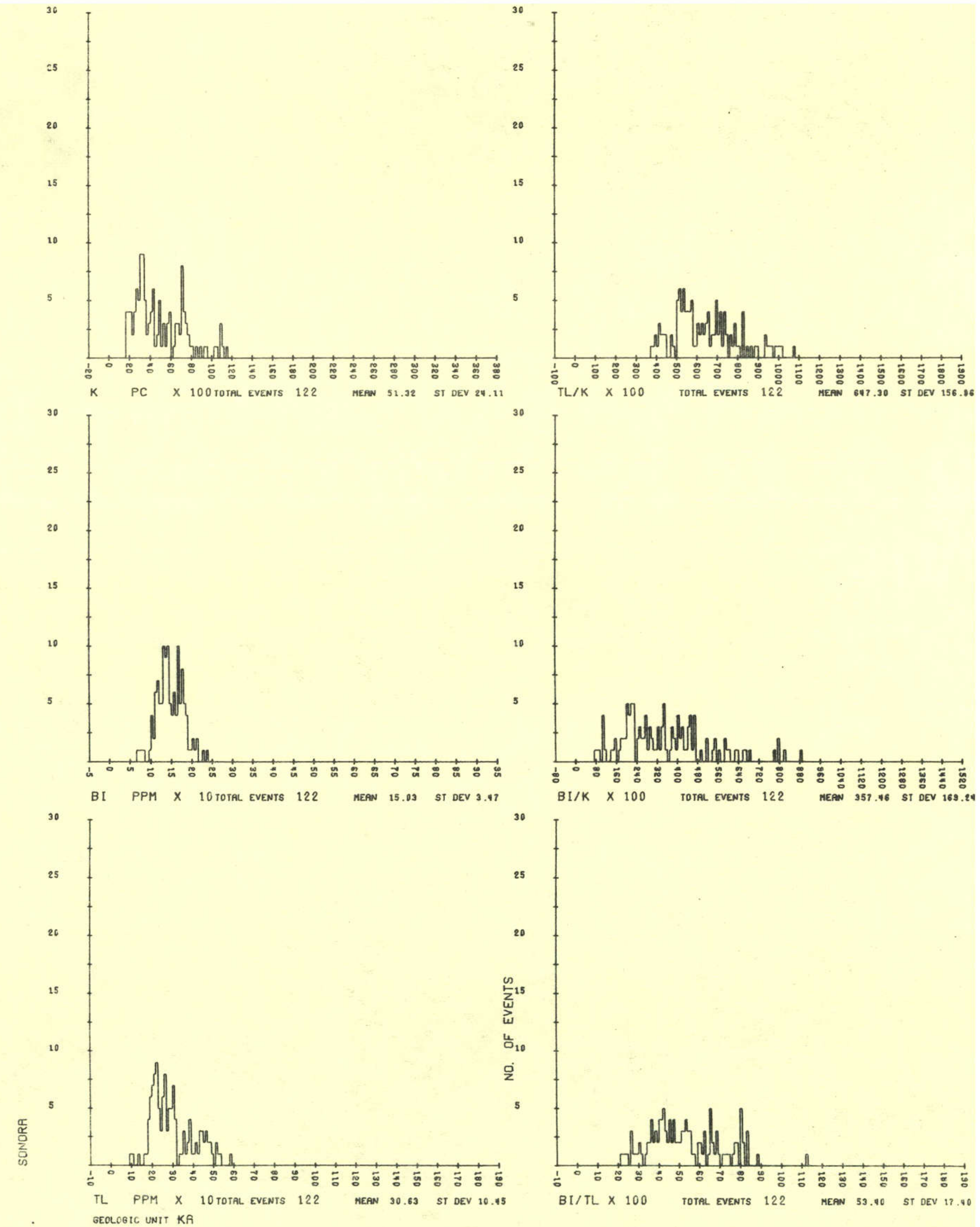
GEOLOGIC UNIT KFT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BI/K X 100 TOTAL EVENTS 122 MEAN 357.46 ST DEV 169.24
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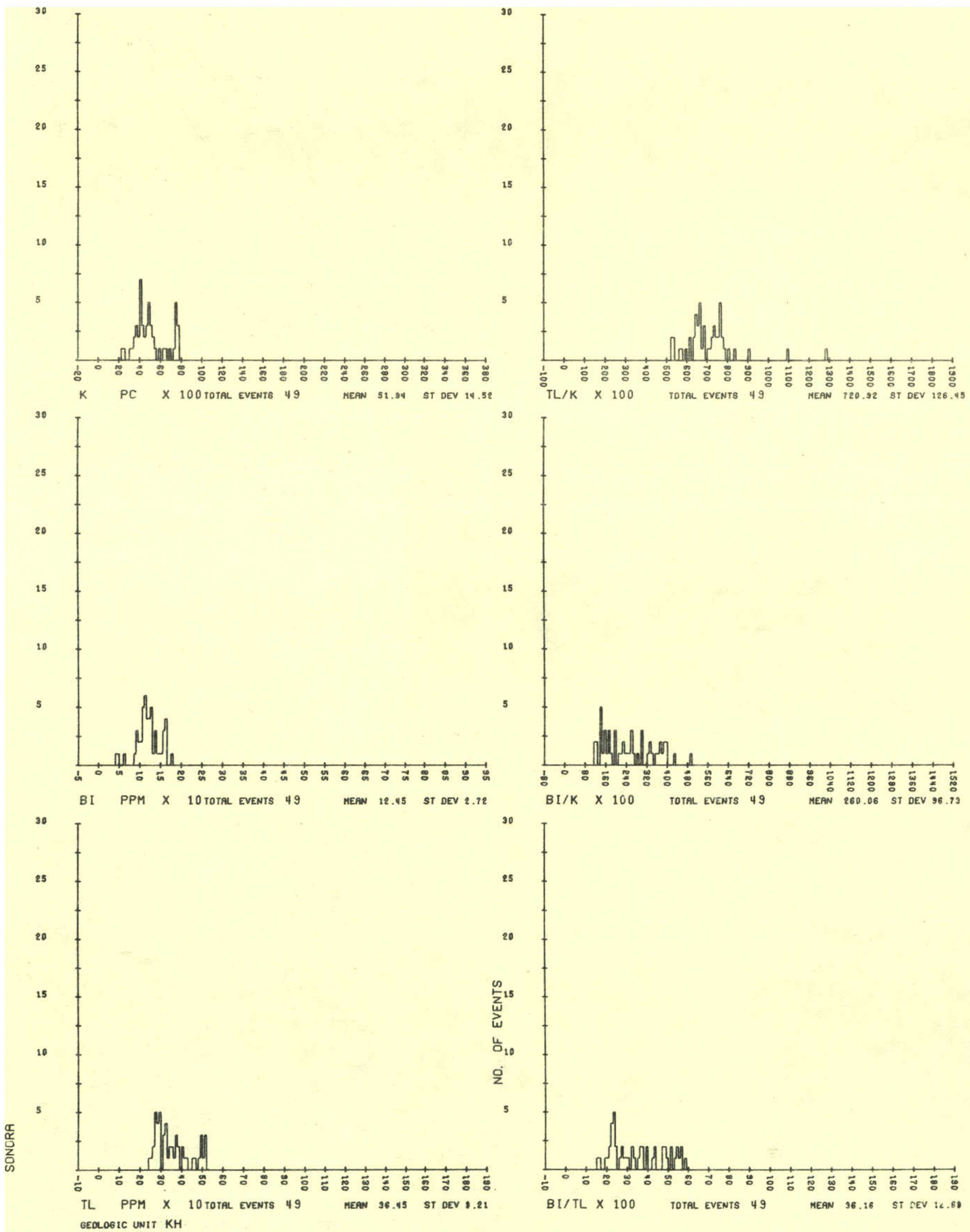
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BI/K X 100 TOTAL EVENTS 49 MEAN 260.06 ST DEV 96.73
TL PPM X 10 TOTAL EVENTS 49 MEAN 36.45 ST DEV 8.21
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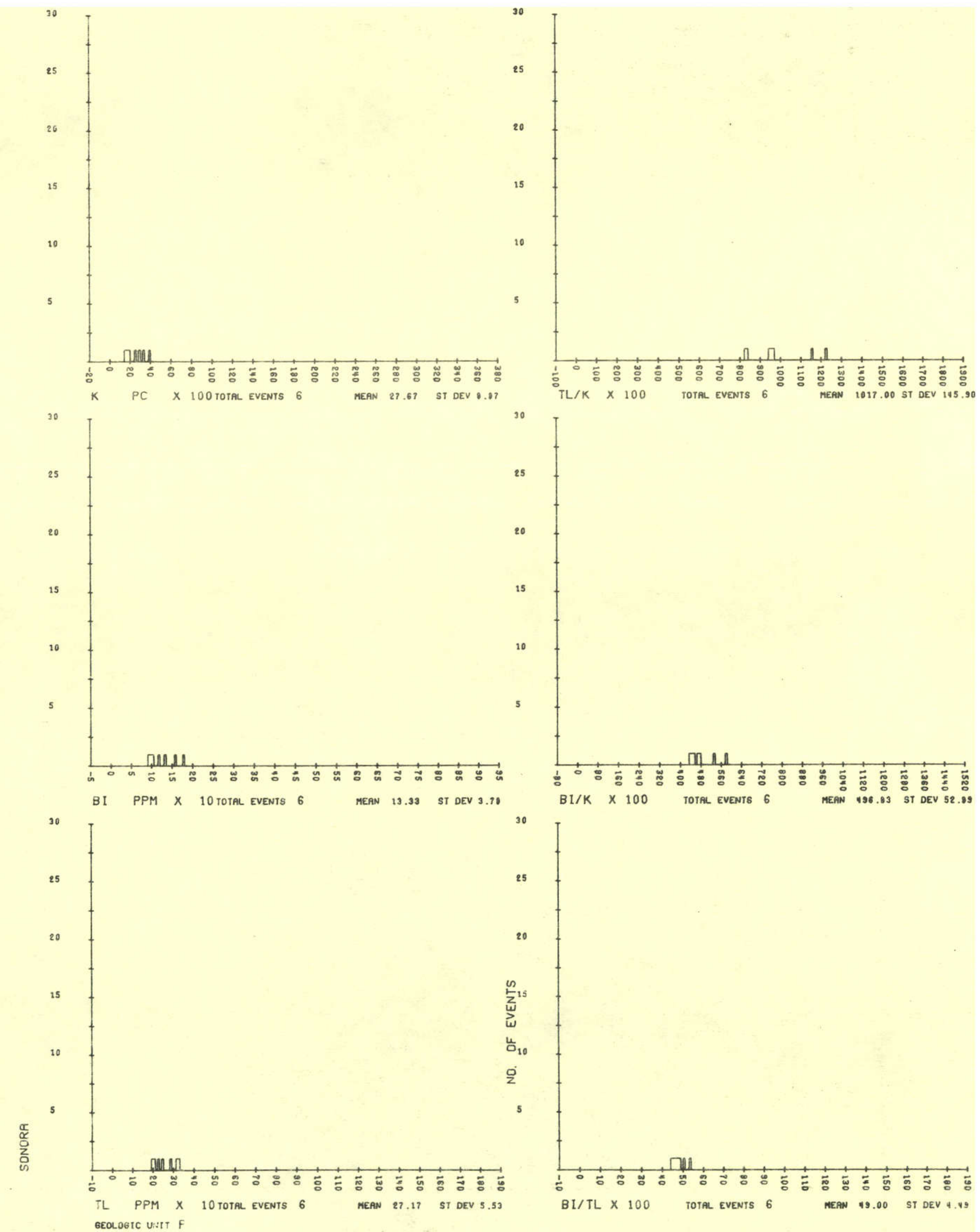
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TL/K X 100 TOTAL EVENTS 6 MEAN 1017.00 ST DEV 145.90
BI PPM X 10 TOTAL EVENTS 6 MEAN 13.33 ST DEV 3.79
BI/K X 100 TOTAL EVENTS 6 MEAN 496.83 ST DEV 52.89
TL PPM X 10 TOTAL EVENTS 6 MEAN 27.17 ST DEV 5.53
BI/TL X 100 TOTAL EVENTS 6 MEAN 49.00 ST DEV 4.49
NO. OF EVENTS
SONORA
GEOLOGIC UNIT F

SECTION V

GEODATA DATA AQUISITION AND PROCESSING

SECTION V.

GEODATA DATA ACQUISITION AND PROCESSING

A. DATA ACQUISITION SYSTEM

A brief description of the computer-linked Geodata Data Acquisition System (GDAS), used in the present survey, is presented here. The five primary components of the GDAS, which are mounted aboard a Douglas Super DC-3 aircraft, Figure V.1, are:

1) An array of nine (9) 11½" dia. by 4" thick $NaI(T\ell)$ detectors;

2) a NOVA mini-computer system

3) a Collins ALT-50 radar altimeter system;

4) a proton precession magnetometer; and

5) a Bendix DRA-12C doppler navigation system.

The nine-crystal detector array has been calibrated to measure the gamma radiation spectrum between 0-6 MeV. The contents of the 3 to 6 MeV interval is monitored in order to reduce the contributions of the cosmic events in the 0-3 MeV interval, which is of primary interest in this survey. Eight of the nine detectors are mounted to measure the 4π solid angle gamma radiation spectrum emanating from the earth's surface. The ninth detector, which is partially shielded underneath by a 3.5-inch lead plate, is situated to measure the ^{214}Bi radiation incoming from the upper 2π solid angle.

Each crystal detector has an estimated volume of 415.5 cubic inches, resulting in a total volume for the entire 4π system of 3324 cubic inches. The estimated volume to velocity ratio for this sytem is 23.7, where the average speed for the DC3-S is approximately 140 mph.

The energy resolution of the GDAS as calculated from the ^{137}Cs 662 keV photopeak was 10.7%, where each individual crystal was 9.0% or better. Automatic digital gain calibration for the eight detector array and the single detector system was accomplished by stabilizing on the ^{40}K photopeak data.

The NOVA computer, shown in the system block diagram of Figure V.2. is the control center of the GDAS. The data is gathered by the computer for every one-second period in a manner giving no dead time when readout to the magnetic tapes for storage. Two magnetic tape recorders are used; one to record the total spectral data and the computer tabulated results (LDT), and the other to record only the computer tabulated results (CDT).

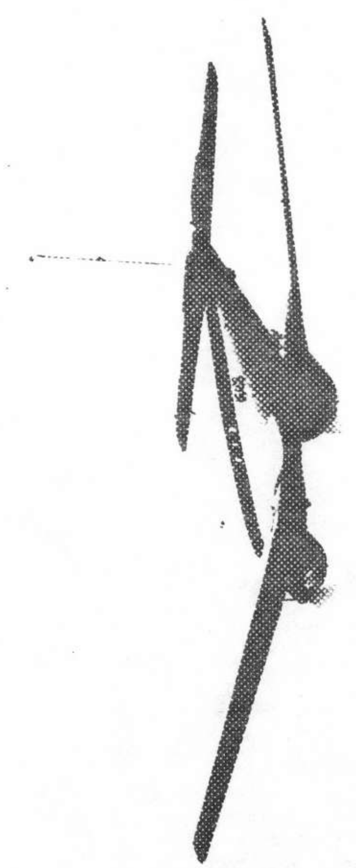


Figure V.1 Survey Aircraft

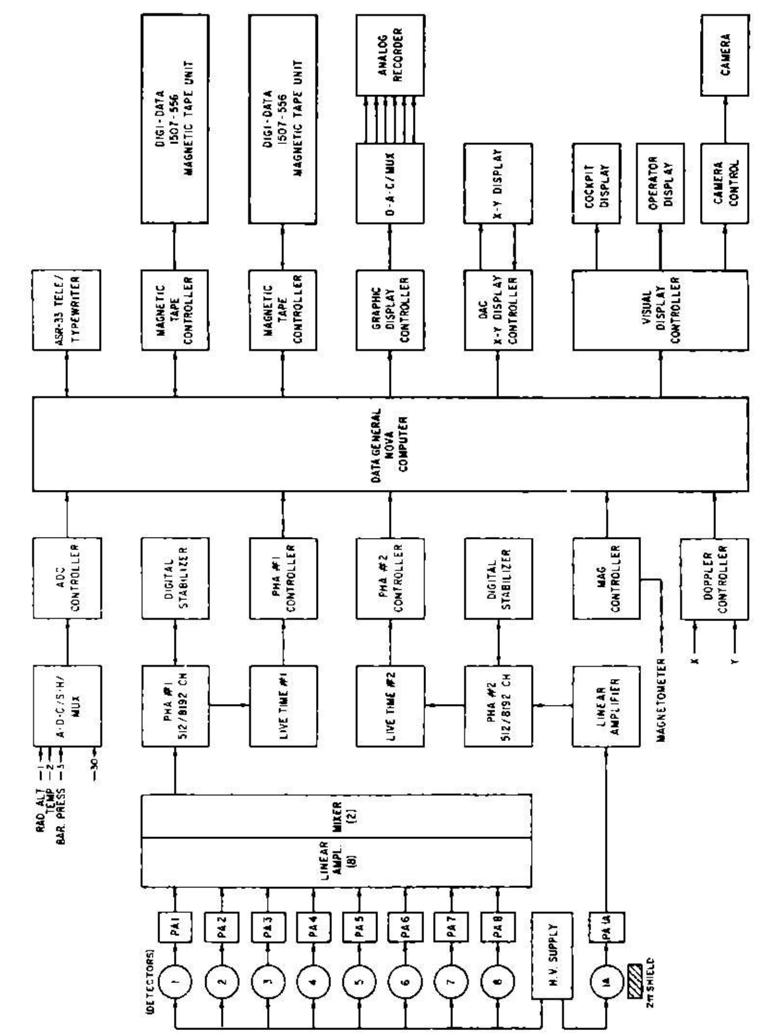


Figure V.2 System Block Diagram

Digital-to-analog conversion of the resultant intensities, their ratios and the magnetic field data are plotted on multi-track paper, allowing immediate examination for anomalous data.

The spectral data from the single detector system gathers and records the 2π spectral data every nine seconds. This 2π data is necessary to determine the amount of atmospheric ^{214}Bi radiation in the 4π spectral data. A third segment of the computer's core gathers and sums the total 2π and 4π gamma radiation spectra for each flight line, which can then be plotted as shown in Figure V.3 (EOFL spectrum).

Due to the dependence of the gamma ray data on altitude, a highly accurate radar altimeter is used. The Collins ALT-50 system is designed to make a series of 8 measurements per second, where the resulting altitude is the average.

Since the gathered data are dependent on the current ambient temperature and pressure readings, a Senso-Tek barometric pressure sensor and a Hy-Col thermocouple sensor were used to monitor conditions outside the aircraft.

A proton precession magnetometer sensor, having a 0.25 gamma readout resolution and less than a 1.0 gamma noise envelope, is sampled every second to yield a measurement of the total intensity of the earth's magnetic field below the aircraft. The sensor is carried as a "bird" on a 100-foot cable in order to minimize the magnetic effects of the aircraft.

A Bendix DRA-12C navigation system with a ±100th/nautical mile accuracy provides a doppler navigation cross-track and along-track analog signal to be recorded each second onto magnetic tape. Two other methods are used to properly locate the aircraft's track: visual sightings and photography. The first method is employed by the navigator who marks flight map location reference points with computer-displayed record numbers. The second method is a 35mm film that records a continuous, recoverable track which has a 20% overlap/frame at an elevation of 400 feet.

There are three basic operating modes of the GDAS that the operator can manipulate:

1) CALIBRATE, which allows proper gain calibration for the detectors;

2) OPERATE, which allows data to be collected, summed and recorded; and

3) PLAYBACK, which allows the operator to examine the newly acquired data.

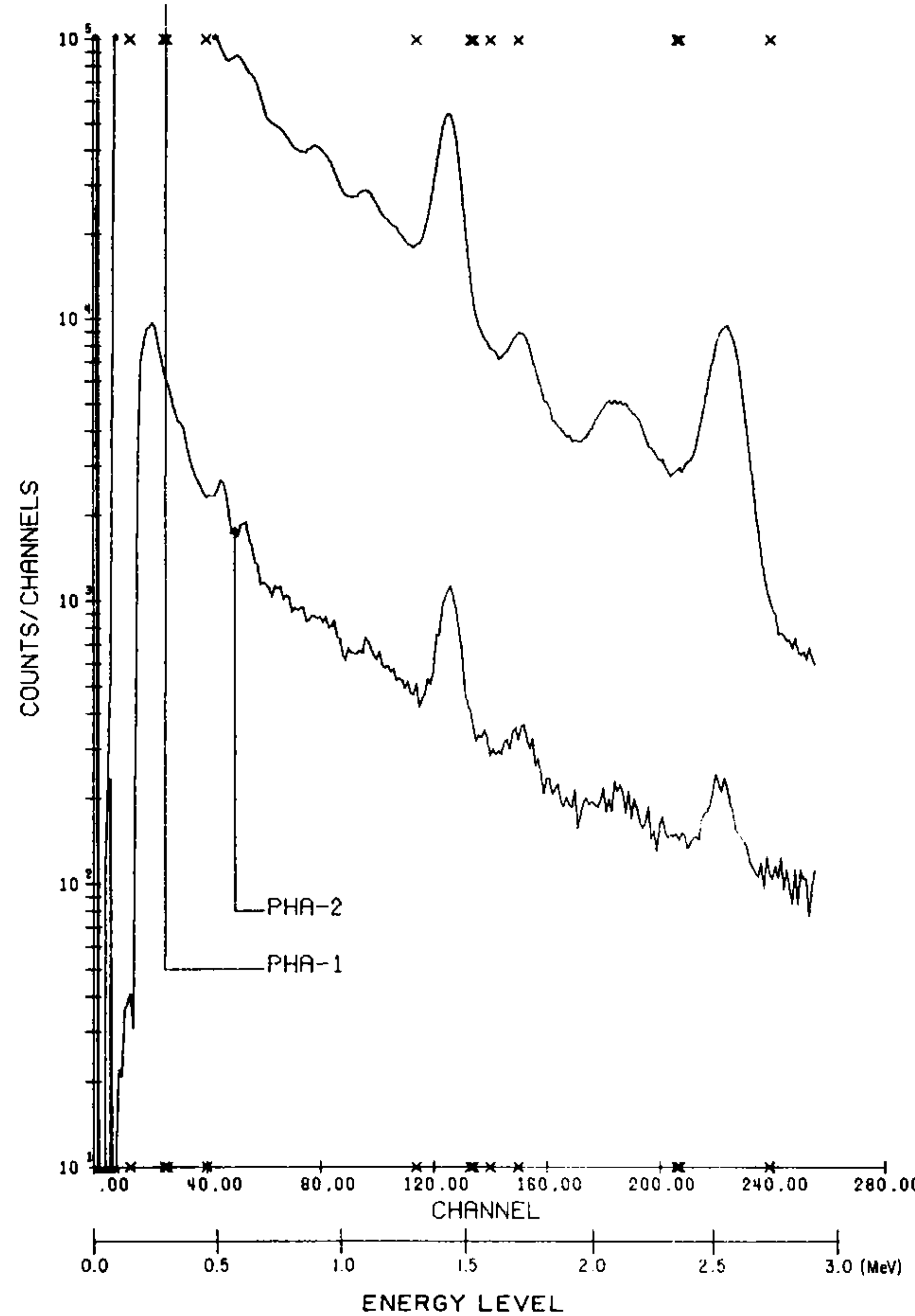


Figure V.3 Typical End-of-Flight-Line Spectral Plot

B. DATA PROCESSING

1. Data Reduction

The field data tapes produced by the data acquisition system (Section V.A) contain the 4π and 2π gamma radiation spectra, measured between 0 to 6 MeV. The resulting gamma ray spectra are composite spectra of the several different isotopes that emit gamma rays within the detectors' energy range. The method used in this work to determine the concentrations of the different isotopes monitored is discussed in this section.

In this work, there are four different isotopes which contributed to the resultant composite spectra under consideration. In order of the highest to lowest energy emitter, they are: cosmic, eTh, eU and K counting rates.

Isotope	Energy Interval (MeV)
Cosmic	3.0 to 6.0
^{208}Tl	2.410 to 2.796
^{214}Bi	1.661 to 1.860
^{40}K	1.357 to 1.556

Due to the occurrence of Compton scatter at all gamma ray energy intervals, a 4 x 4 matrix method approach is used to "spectrally strip" the group summed counting rates into their individual counting rates attributed only to the isotope associated with that energy interval.

This matrix method approach is theoretically applicable to a spectrum containing any number of isotopic gamma rays. For convenience, the four isotopes will be denoted as: COS, TL, BI and K. The channel group sum for each energy interval can be considered to consist of fractional components of each of its constituents. For instance, one can write for the TL channel group sum:

$$aCOS + 1.0TL + fBI + 0.0K = MTL$$

where MTL is the channel group sum count;

and the coefficients, which are known as Compton coefficients, for each variable represent the responses of the data gathering system to each isotope over the entire energy spectrum.

Similarly, equations can be written for the energy interval group sums for MCOS, MBI and MK, as shown below in matrix notation by

$$\begin{bmatrix} 1.0 & 0.0 & 0.0 & 0.0 \\ a & 1.0 & f & 0.0 \\ b & \alpha & 1.0 & g \\ c & \beta & \gamma & 1.0 \end{bmatrix} \begin{bmatrix} COS \\ TL \\ BI \\ K \end{bmatrix} = \begin{bmatrix} MCOS \\ MTL \\ MBI \\ MK \end{bmatrix}$$

where each element of the 4 x 4 matrix is a Compton coefficient. By inverting the 4 x 4 matrix and multiplying on the left by the channel group sum matrix, the resulting column matrix, whose elements are COS, TL, BI, and K, represents the counts in each energy interval attributed only to the indicated isotope source.

Table V.1 contains the data reduction parameters, coefficients and backgrounds used in this survey. The listed Compton coefficients were determined from data acquired during high altitude flights and from "known" test pad data concentrations in Grand Junction, Colorado.

The resulting reduced counting rates for COS, TL, BI and K must then be normalized with respect to the measured live time counting rate of the data acquisition system. This is necessary in order to restore the linear relationship between the photopeak counts and the source's intensity. This procedure is accomplished by dividing the reduced counts by the live time, LTC1:

thus,

COS1	=	COS/LTC1
TL1	=	TL/LTC1
BI1	=	BI/LTC1
K1	=	K/LTC1

The next step in the data processing involves the subtraction of the background counts present onboard the aircraft. The background counts, which exist in the aircraft and its equipment, are determined from high altitude data where the data acquisition is free from all ground sources and atmospheric ^{214}Bi contamination. The background counts, denoted as B_{TL}, B_{BI} and B_K, used in this work are listed in Table V.1. During the processing, the backgrounds are checked by observing the resulting counting rates over large bodies of water, where the rates would have near zero intensities. The gross count's background counting rate, B_{GC}, over channels 35-239, is also given in Table V.1.

After the backgrounds have been subtracted from the live time corrected photopeak counts, thus

$$\overline{TL1} = TL1 - B_{T\ell}$$

$$\overline{BI1} = BI1 - B_{Bi}$$

$$\overline{K1} = K1 - B_K$$

The resulting counting rates for $\overline{TL1}$ and $\overline{K1}$ represent the counts contributed only by the sources below the aircraft on the earth's surface. In the case of $\overline{BI1}$, an additional source of ^{214}Bi radiation, which is caused by atmospheric ^{214}Bi, BIAIR, is still eminent.

The 2π detector system data is used to determine the magnitude of the BIAIR to be subtracted. Since the predominate variable source affecting the 2π detector is the atmospheric ^{214}Bi, it is possible to utilize most of the 2π spectrum in the BIAIR determination, and thereby produce some improvement in the statistical error. The energy interval used for the 2π crystal is between 1.05 to 2.79 MeV. Within this interval, the aircraft's background, $B_{2\pi}$, and its Compton coefficient, $C_{2\pi}$, have been determined from the high altitude data. (See Table V.1).

The BIAIR associated with the unshielded detector array is determined, using the shielded detector by the relation:

$$BIAIR = \left(\frac{G(x)}{1 - k_2 G(x)}\right) [VC - C_{2\pi} \cdot COS1 - b_{2\pi} - RVALM]$$

where

G(x)	is the relationship between the 4π and 2π solid angles, the channel group sums and the number of detectors in the detector arrays;
VC	is the 2π total count group sum of channels 91-239, c/s:
COS1	is the 4π cosmic count, greater than 3.0 MeV, c/s;

and,

$$RVALM = k_1 \overline{TL1} + k_2 \overline{BI1} + k_3 \overline{K1}$$

where k_1, k_2, k_3 are constant factors that correct for the penetration/spill of the emanated surface radiation. These penetration/spill constants are dependent on the amount of lead shielding used on the 2π crystal. The values used in this work are listed in Table V.1.

$\overline{TL1}$, $\overline{BI1}$ and $\overline{K1}$ have already been defined as the 4π reduced data counting rates, c/s.

Finally, the ^{214}Bi counting rate caused only by the surface sources is given by

$$BISUR = \overline{BI1} - BIAIR$$

Briefly summarizing, $\overline{TL1}$, BISUR and $\overline{K1}$ are the counting rates as measured at the height of the aircraft. All interfering counts from cosmic, backgrounds and atmospheric ^{214}Bi have been removed.

Since the various counting rates are dependent upon the height of the aircraft above the surface terrain, it is necessary to correct the associated isotope's counting rate to an altitude of 400 feet above the surface terrain. This is accomplished through the equations indicated below:

$$TLS = \overline{TL1} \cdot e^{-\mu_1 (400 - \frac{\rho}{\rho_o} x)}$$

$$BIS = BISUR \cdot e^{-\mu_2 (400 - \frac{\rho}{\rho_o} x)}$$

$$KS = \overline{K1} \cdot e^{-\mu_3 (400 - \frac{\rho}{\rho_o} x)}$$

and

$$GC(\text{gross count}) = (\overline{GC} - B_{GC} - S \cdot BIAIR) \cdot e^{-\mu_4 (400 - \frac{\rho}{\rho_o} x)}$$

where

$\overline{GC}$	is the live time corrected gross count, channels 35-239,
S	is the ratio of the BI data, channels 35-239 to channels 143-159,
B_{GC}	is the gross count background,

TLS,BIS,KS	are the respective photopeak's counting rates at 400 feet;
ρ_o	is the air density at standard temperature and pressure; 0.001293 gm/cc
ρ	is the air density at the time the survey data was flown;
μ_1,μ_2,μ_3,μ_4	are the respective linear attenuation coefficients;
x	is the aircraft's height above the surface terrain in feet.

The attenuation coefficients and other constants used in the altitude normalization are listed in Table V.1.

After each flight line of data has undergone the above data reduction, the average values for each radiation variable and variable ratios for each of the flight lines were plotted to demonstrate the consistency of the average values and that a smooth flow continues from day to day, and from the start to the finish of each day.

Diurnal variations of the magnetic field base station intensity were measured and applied to the field data. (See Section II.D and Appendix I.C). The magnetic heading corrections for the aircraft and its equipment used in this survey were determined by flying a predetermined path at a survey altitude in first an east to west direction, then in a west to east direction. The same procedure is used on a north to south path. Based on the data obtained in this fashion, see Table V.1, the heading corrections were removed from all the data. The magnetic field data were then IGRF corrected to give the residual magnetic field. The International Geomagnetic Reference Field subtracted was provided by the U.S. Geological Survey with reference to the IAGA Bulletin #38, "Grid Values and Charts by the IGRF 1975.0", National Technical Information Service Report #PB265483.

The system sensitivities at 400 feet used in this survey are shown in Table V.1.

2. Description of the Data Processing

The processing flow chart representative of the work performed in this survey is shown in Figure V.4.

As stated in Section V.A., the original field data tapes were recorded to contain the various tag words, 4π and 2π spectral

TABLE V-1. DATA REDUCTION PARAMETERS AND CONSTANTS - N540S - 1980

AIRCRAFT BACKGROUNDS				COSMIC CORRECTION RATIOS	
Detector	Parameter	Window	Value (CPS)	Parameter	Value
Terrestrial (4π)	B_K	Potassium	29.98	c	0.2069
	B_{Bi}	Uranium	9.40	b	0.1651
	$B_{T\ell}$	Thorium	5.83	a	0.2202
	B_{GC}	Gross	286.69	-	-
Atmospheric (2π)	$B_{2\pi}$	Uranium	8.33	$C_{2\pi}$	0.2232

DERIVED STRIPPING COEFFICIENTS AND RATIOS			
Coefficient	Value	Coefficient	Value
α	0.2755	k_1	0.030
β	0.4058	k_2	0.0
γ	0.8595	k_3	0.0
f	0.0693	S	17.5
g	0.0156	-	-

LINEAR ABSORPTION COEFFICIENTS		
Radio Element	Parameter	Value ($x10^{-3}$ per ft.)
Potassium	μ_1	2.448
Uranium	μ_2	1.329
Thorium	μ_3	1.899
Gross	μ_4	1.430

MAGNETIC HEADING CORRECTION	
Flight Direction	Correction (gammas)
West to East	+3.56
East to West	-3.56
North to South	-1.0
South to North	+1.0

RADIOELEMENT	SYSTEM SENSITIVITIES AT 400 FEET
Potassium (cps/%K)	98.06
Uranium (cps/ppm eU)	13.52
Thorium (cps/ppm eTh)	7.15

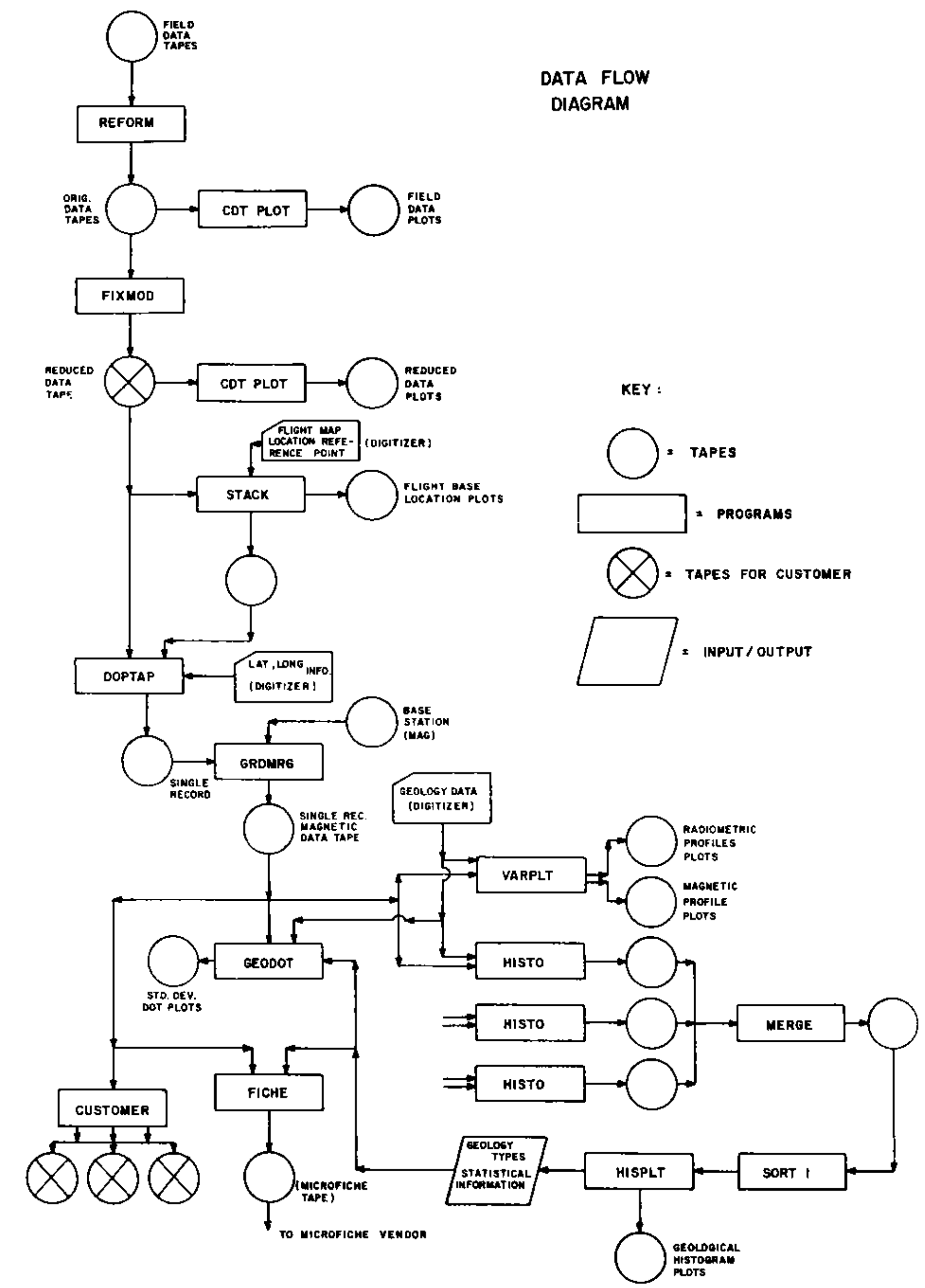


Figure V.4 Data Reduction Flow Chart

data and the trailer record sums for each flight line. The purpose of the REFORM program is to sum the raw spectral data (LDT) into the proper group sum energy intervals for each second for each line. The CDTPLT program is a data certification program that produces the EOFL spectral plots, Figure V.3, and profiles of each of the channel group sums, which are plotted as a function of each line's record numbers.

A brief summary of each program and its uses is given below:

PROGRAM	FUNCTION
REFORM	Produces energy group sums and EOFL spectra.
FIXMOD	Primary processing for "spectral stripping" matrix reduction, live time normalization, background and BIAIR subtraction, and altitude corrections.
STACK	Flight path recovery to produce record location map at a scale of 1:250,000.
DOPTAP	Single record processing with latitude/longitude positioning, IGRF and single point statistical adequacy computations, and magnetic heading corrections.
GNDMRG	Merges aircraft magnetometer and ground magnetometer in proper time sequence and applies diurnal corrections to the field data.
VARPLT	Produces radiometric and magnetic stacked profile plot tapes.
HISTO,MERGE, and SORT1	Preliminary programs to prepare/sort data as a function of geologic type for the entire area.
HISPLT	Produces geological histograms,mean and standard deviation tables,and plot tape for the entire area.
GEODOT	Produces plot tape for standard deviation "dot plots" related to geologic type.
FICHE	Produces average record and single record reduced data listings and microfiche tapes, which are sent to microfiche vendor.
CUSTOMER	Produces all customer required tapes.

3. Data Presentation

The surveyed area was positioned geographically to completely cover the specific National Topographic Map. Each topographic map has been used as the flight base and sufficient geographical and 15' location information has been shown. The flight line pattern has been superpositioned onto these created base maps, where the standard deviation levels for each independent variable and each ratio of these variables have been plotted (NGRMS), based on the data contained within the total map area. Every fifth data point along each map line has its standard deviation value shown at the location of that value. Therefore, there are six NGRMS sheets which indicate the location and magnitude of anomalous data.

The multivariable map line profile, which represents 10 variables as a function of their latitude and longitude location for each line, is presented at a scale of 1:500,000. Each profile presents:

1. Aircraft altitude above the surface
2. eTh (^{208}Tℓ from ^{232}Th decay series)
3. eU (^{214}Bi from ^{238}U decay series)
4. K (^{40}K from natural potassium)
5. BIAIR (atmospheric ^{214}Bi)
6. Residual magnetic field
7. Gross count (greater than 400 keV)
8. eU/eTh (^{214}Bi/^{208}Tℓ) ratio
9. eU/K (^{214}Bi/^{40}K) ratio
10. eTh/K (^{208}Tℓ/^{40}K) ratio
11. Geologic data, including aircraft flight path

The residual magnetic field map line profile, which represents five variables as a function of their latitude and longitude location for each line, plus geologic data at a scale of 1:500,000 is presented as:

1. Aircraft altitude
2. Atmospheric temperature
3. Atmospheric pressure
4. Residual magnetic field data
5. Magnetic field base line station data
6. Geological data, including aircraft flight path

The output of these various computations supplies, beyond two profile sets, the following data:

* Histograms of the radiation data distribution within each geologic unit.

* Histograms of the average velocity distribution for each one-second record for each map and tie line.
* Histograms of the average altitude distribution for each one-second record for each map and tie line.
* Tables giving the average radiation concentration of each geologic unit for each flight line.
* Average radiation concentration for each variable as a function of flight line, including the atmospheric ^{214}Bi.
* Set of maps showing the standard deviation data as a function of location and radiation variable.
* Printer plot contour maps of eTh, eU, K, eU/K, eU/eTh, eTh/K and the magnetics at a scale of 1:500,000.

4. Statistical Analysis Procedures

It is necessary to exclude from the statistical analysis all variables which have too low a counting rate to be statistically valid, and data which were obtained at altitudes above 1,000 feet. To this end, a statistical adequacy test was run on all data for each data record. If a given value of Tℓ, Bi or K failed the test, that variable value, and any ratio value associated with it, were not used in the statistical determinations of mean and standard deviation values. In addition, such values are indicated on the radiometric profiles by a vertical (tick) mark along the base line for the variable, and are flagged in the single record and averaged record listings (microfiche). The ratio values are set to zero in the Radiometric Profile Plots. The flags in the listings appear under the heading AKUT for altitude, ^{40}K, ^{214}Bi and ^{208}Tℓ, respectively. The flags are zero for statistically valid data, and one for rejected data in the case of K, U and T. For altitude (A), a zero indicates altitudes to 700 feet, a one (1) indicates altitudes between 700 and 1,000 feet, and a two (2) indicates altitudes above 1,000 feet.

The tests used to reject data were as follows:

$$(1)\quad \overline{T\ell I} < 1.5 \sqrt{T\ell w - \overline{T\ell I}} = 1.5\sigma T$$

$$(2)\quad BISUR < 1.5 \sqrt{Biw - BISUR} = 1.5\sigma B$$

$$(3)\quad \overline{KI} < 1.5 \sqrt{Kw - \overline{KI}} \approx 1.5\sigma K$$

where the "w" subscript refers to the respective window counting rates from the raw data and $\overline{T\ell 1}$, BISUR and $\overline{K1}$ have previously been defined. If any of the above inequalities were true, the associated variable was flagged, and that value was rejected in all statistical determinations.

The values of the radicals in the above equations, which are indicated as σT, σB, σK and the barred values, were calculated on the basis of a single record value for determining flags in the single record listings and the 7-point weighted values for determining flags in the averaged records listings.

The mean value and standard deviations were calculated assuming the data to have a normal distribution within a geologic type. The equation used in determining the variance is:

$$\sigma^2 = \frac{1}{N-1}\left\{\sum_{i=1}^{N} x_i^2 - N\bar{x}^2\right\}$$

where N is the number of statistically valid samples for a given geologic type, x_i is the value of the variable for sample number i, and $\bar{x}$ is the mean value of the variable for the geologic type. Values from the entire survey of the area are used in these computations.

APPENDICES

I PRODUCTION SUMMARY

II TAPE FORMAT STATEMENTS

III COMPUTER LISTINGS

IV LINE PRINTER CONTOURS

AI.A PRODUCTION SUMMARY - SURVEY TIME PERIOD

ML/TL	DATE FLOWN	SURVEY LINE MILES	AVERAGE SPEED/DAY	AVERAGE ALTITUDE/DAY
5020,5040	2/20/80	140.31	138.77	404.13
20,40, 5060-5200	2/28/80	800.77	140.87	403.83
60-180	2/29/80	846.40	139.37	405.39
200-300	3/1/80	715.07	140.71	420.88
320-380	3/28/80	480.44	143.91	424.57
400-460	3/29/80	483.64	141.69	411.74

AI.B TEST LINE RESULTS

	1980					
UNIT	2/20	2/28	2/29	3/1	3/28	3/29
PRE COS	-	41.33	42.74	40.78	44.03	41.38
POS COS	-	41.33	42.35	-	44.45	44.34
TI	-	25.37	26.92	26.61	29.16	35.86
TI	-	26.08	27.43	-	28.43	33.55
Bi	-	22.88	22.40	18.97	17.21	16.78
Bi	-	22.68	21.94	-	19.29	16.80
K	-	37.02	43.72	43.97	44.21	65.50
K	-	37.89	43.58	-	46.02	65.17
GC	-	1060.08	1039.27	1028.01	1025.56	1190.93
GC	-	1059.70	1052.29	-	1069.12	1208.78
BiAir	-	6.86	18.41	1.23	12.68	5.88
BiAir	-	15.07	19.71	-	17.14	12.34
ALT	-	389.69	388.67	408.41	422.35	408.84
ALT	-	407.28	387.34	-	396.33	415.49

AI.C DIURNAL CORRECTIONS TO LINE DATA

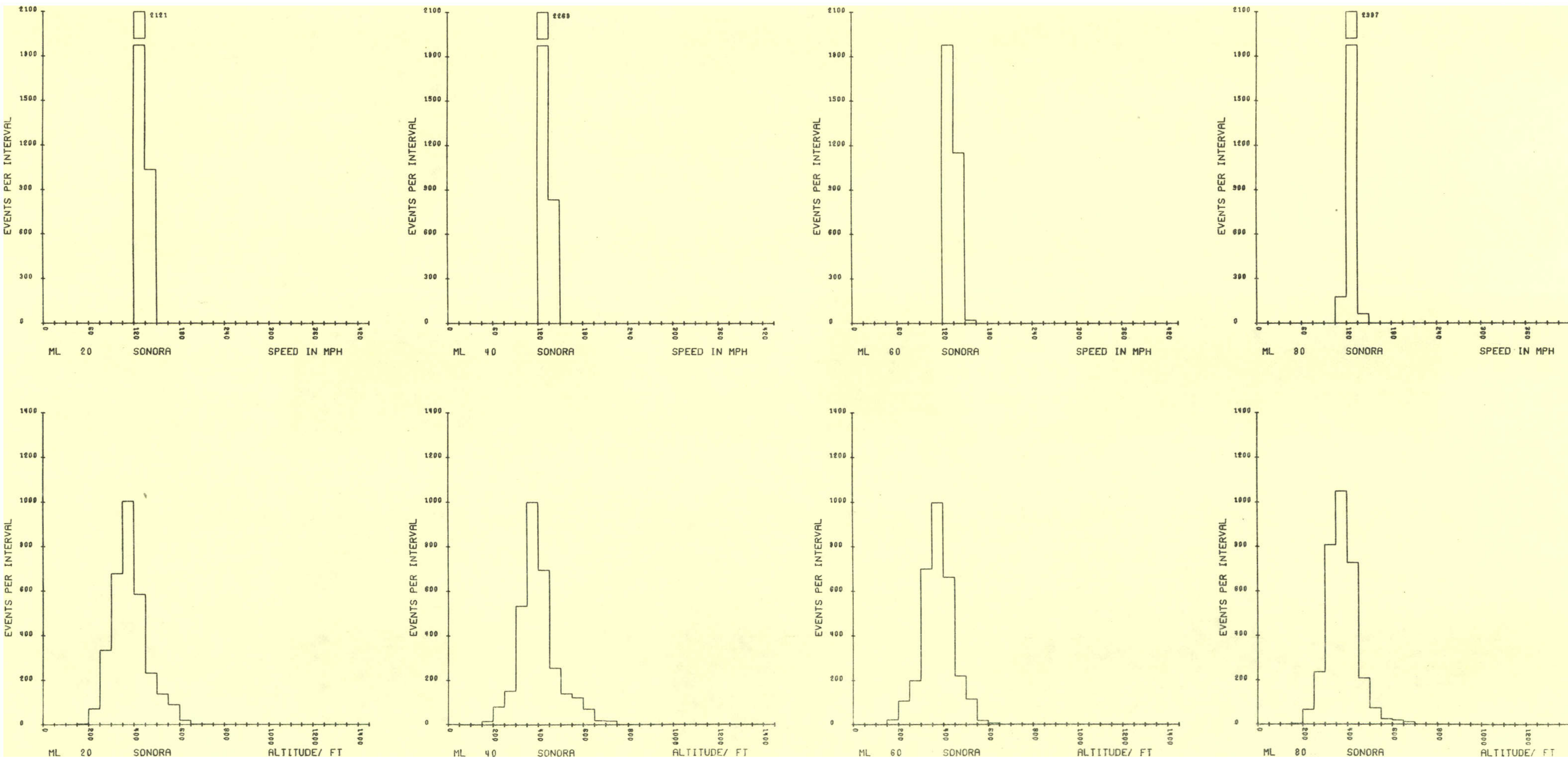
LINE	DIURNAL CORRECTIONS IN GAMMAS	LINE	DIURNAL CORRECTIONS IN GAMMAS
20	-3		
40	-5		
60	4		
80	3		
100	3		
120	0		
140	0		
160	-6		
180	0		
200	18		
201	-2		
220	-2		
221	11		
240	11		
241	-6		
260	-7		
280	-3		
300	-3		
320	-19		
340	-27		
360	-26		
380	-35		
400	-15		
420	-9		
440	-5		
460	-15		
5020	4		
5040	5		
5060	5		
5080	6		
5100	4		
5120	6		
5140	4		
5160	4		
5180	2		
5200	3		

AI.D EXPLANATORY NOTES

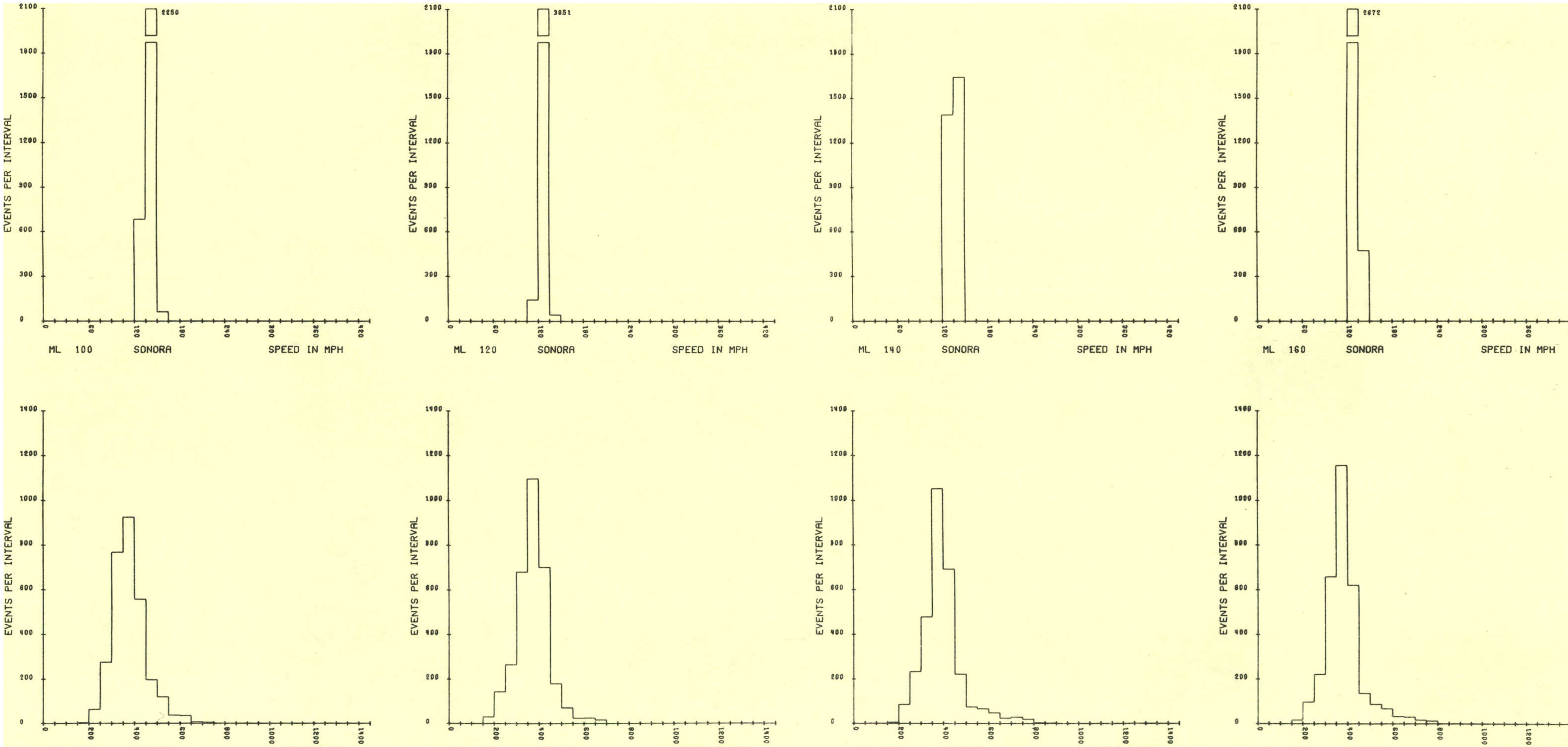
There were no problems with this quad.

AI.E AVERAGE SPEED AND ALTITUDE DATA SUMMARY

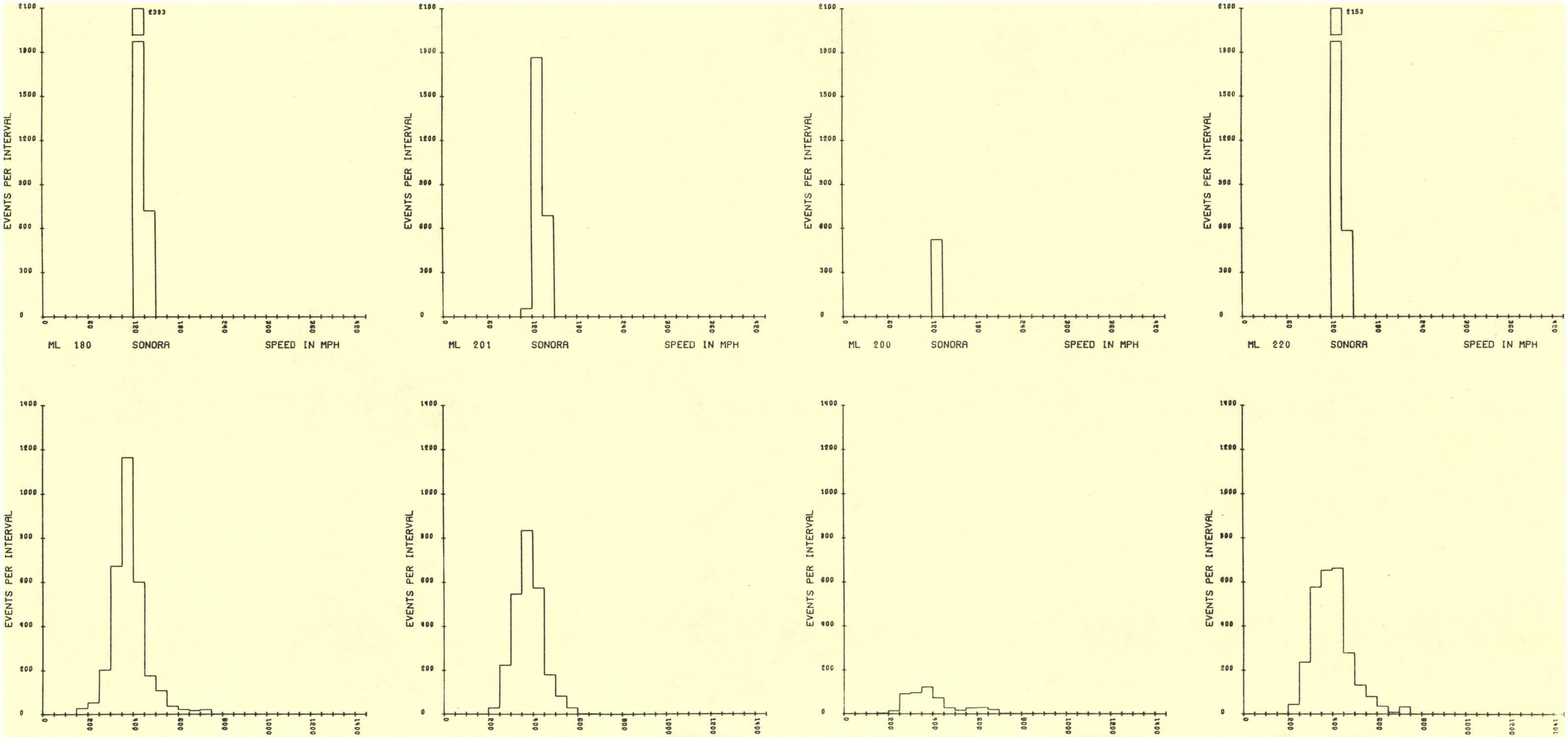
LINE	AVERAGE SPEED, MPH	AVERAGE ALTITUDE, FT	LINE	AVERAGE SPEED, MPH	AVERAGE ALTITUDE, FT
ML20	140	406			
ML40	139	425			
ML60	141	401			
ML80	134	402			
ML100	147	403			
ML120	135	397			
ML140	143	420			
ML160	137	408			
ML180	138	407			
ML201	139	405			
ML200	135	421			
ML220	138	422			
ML221	139	416			
ML241	138	416			
ML240	139	421			
ML260	146	430			
ML280	144	423			
ML300	148	433			
ML320	137	417			
ML340	150	422			
ML360	136	403			
ML380	153	456			
ML400	138	411			
ML420	140	407			
ML440	139	404			
ML460	150	424			
TL5020	136	405			
TL5040	142	404			
TL5060	149	392			
TL5080	135	388			
TL5100	145	395			
TL5120	135	392			
TL5140	146	395			
TL5160	137	402			
TL5180	146	420			
TL5200	137	423			

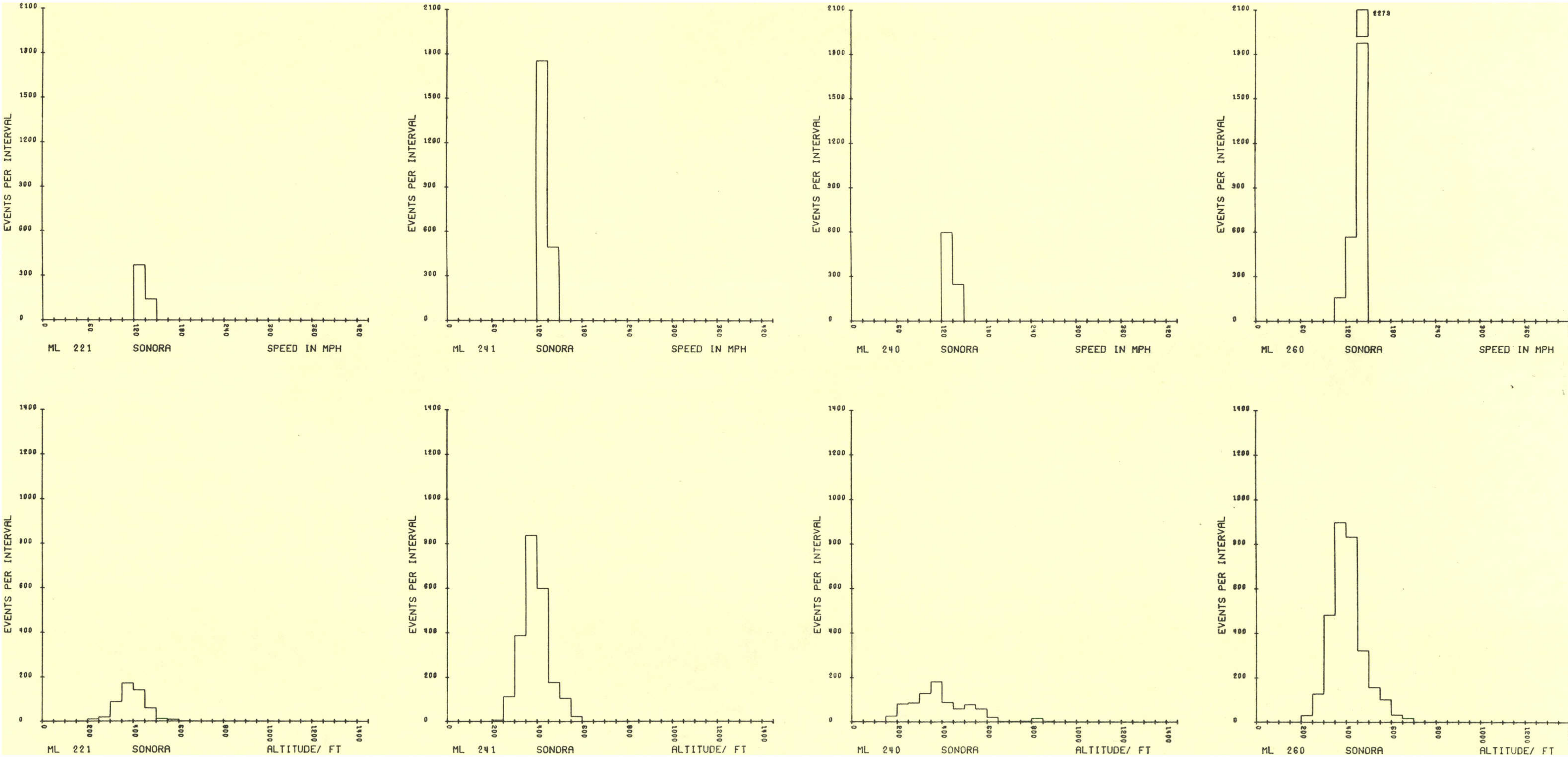


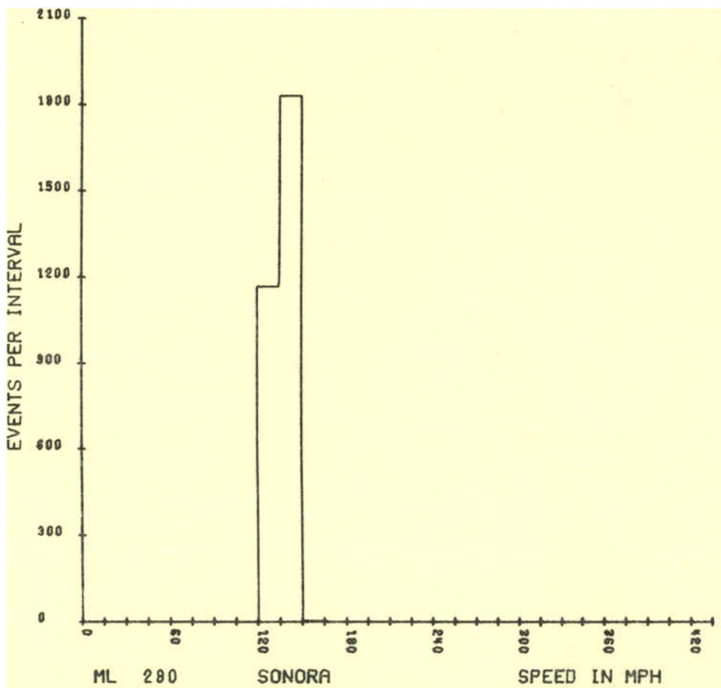
EVENTS PER INTERVAL
2121
ML 20 SONORA SPEED IN MPH
2263
ML 40 SONORA SPEED IN MPH
ML 60 SONORA SPEED IN MPH
2397
ML 80 SONORA SPEED IN MPH
ML 20 SONORA ALTITUDE/ FT
ML 40 SONORA ALTITUDE/ FT
ML 60 SONORA ALTITUDE/ FT
ML 80 SONORA ALTITUDE/ FT

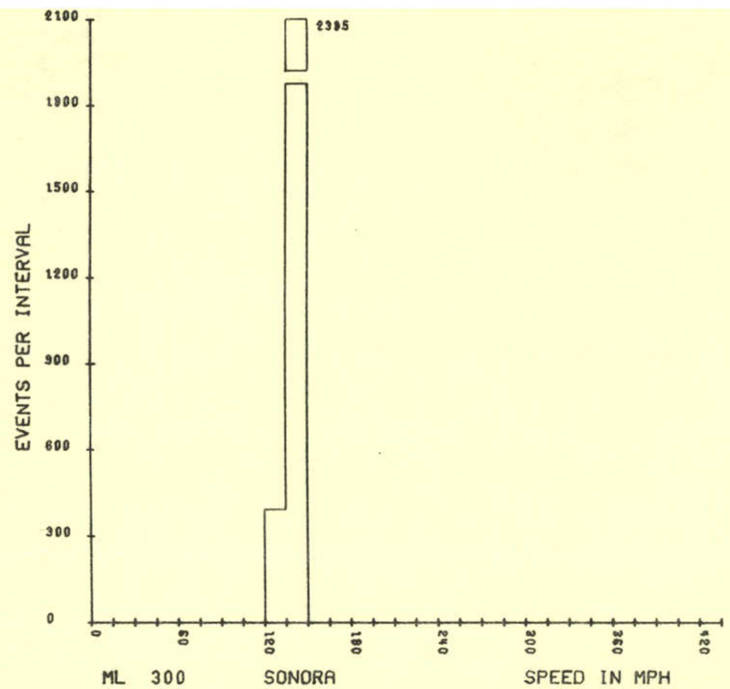


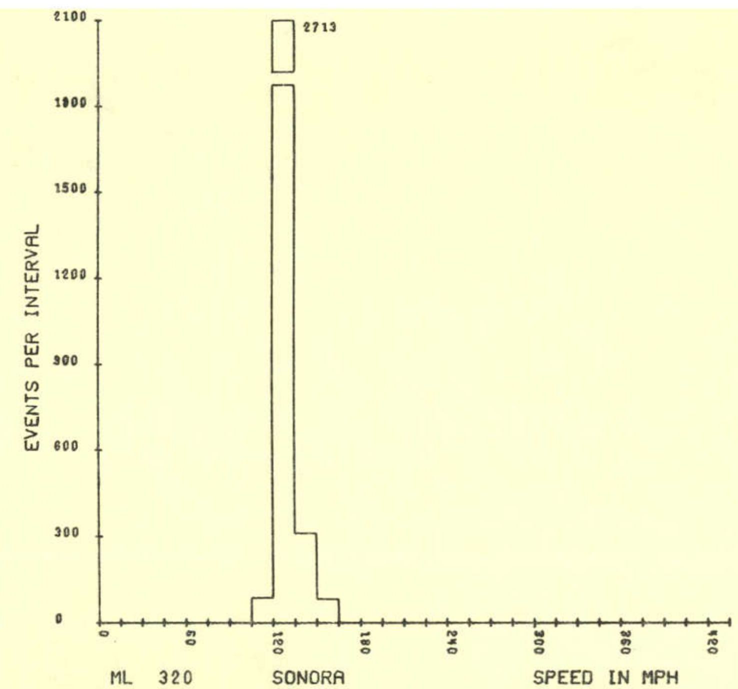
EVENTS PER INTERVAL
2250
3051
2672
ML 100 SONORA SPEED IN MPH
ML 120 SONORA SPEED IN MPH
ML 140 SONORA SPEED IN MPH
ML 160 SONORA SPEED IN MPH
ML 100 SONORA ALTITUDE/ FT
ML 120 SONORA ALTITUDE/ FT
ML 140 SONORA ALTITUDE/ FT
ML 160 SONORA ALTITUDE/ FT

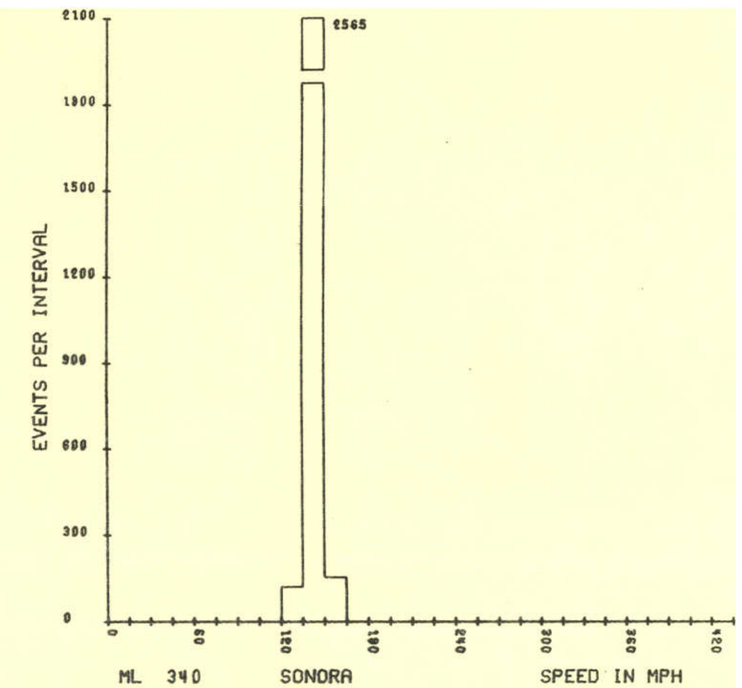

EVENTS PER INTERVAL
2393
ML 180 SONORA SPEED IN MPH
ML 201 SONORA SPEED IN MPH
ML 200 SONORA SPEED IN MPH
2153
ML 220 SONORA SPEED IN MPH
ML 180 SONORA ALTITUDE/ FT
ML 201 SONORA ALTITUDE/ FT
ML 200 SONORA ALTITUDE/ FT
ML 220 SONORA ALTITUDE/ FT

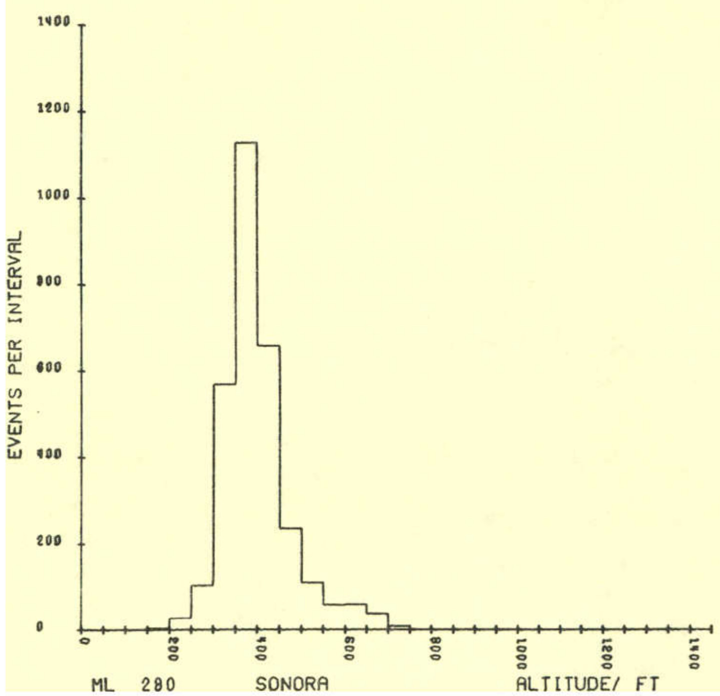

EVENTS PER INTERVAL
ML 221
SONORA
SPEED IN MPH
ML 241
SONORA
SPEED IN MPH
ML 240
SONORA
SPEED IN MPH
2273
ML 260
SONORA
SPEED IN MPH
ML 221
SONORA
ALTITUDE/ FT
ML 241
SONORA
ALTITUDE/ FT
ML 240
SONORA
ALTITUDE/ FT
ML 260
SONORA
ALTITUDE/ FT

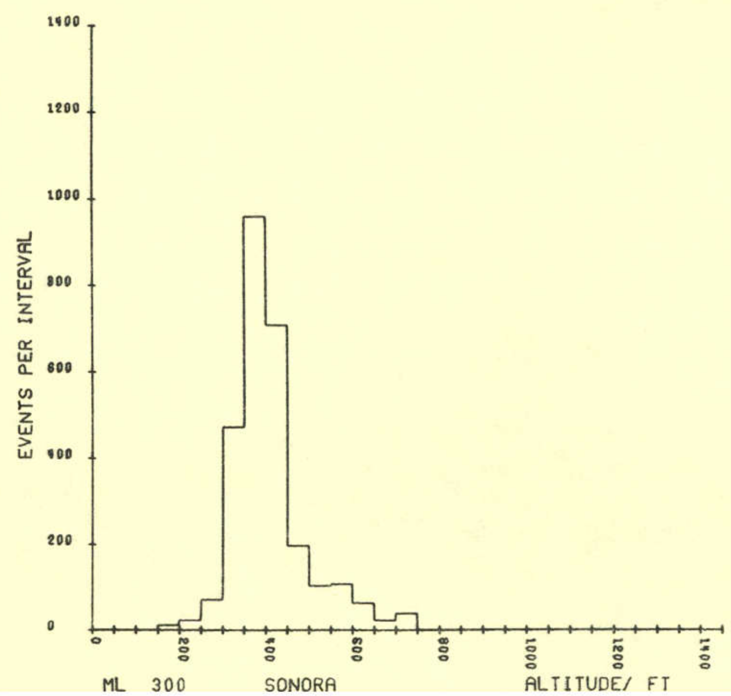

EVENTS PER INTERVAL
ML 280
SONORA
SPEED IN MPH

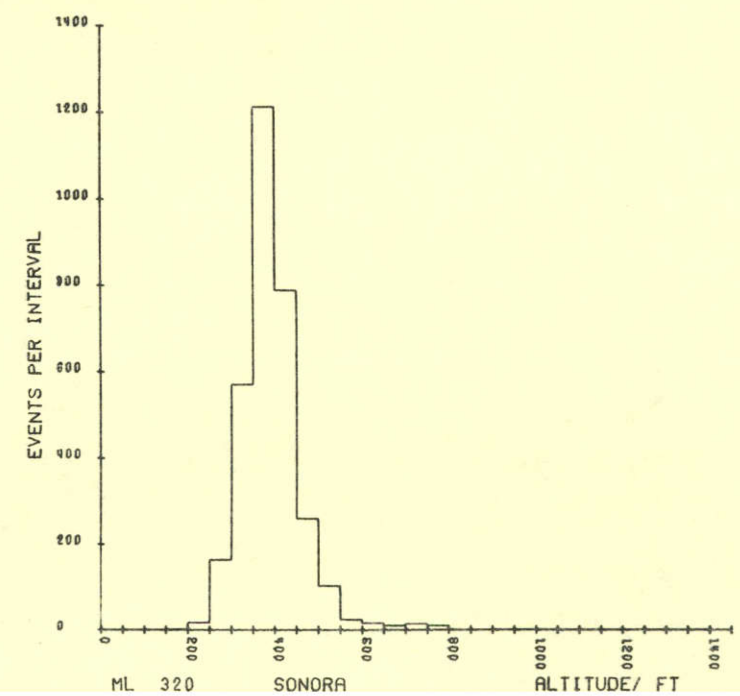

2395
EVENTS PER INTERVAL
ML 300
SONORA
SPEED IN MPH

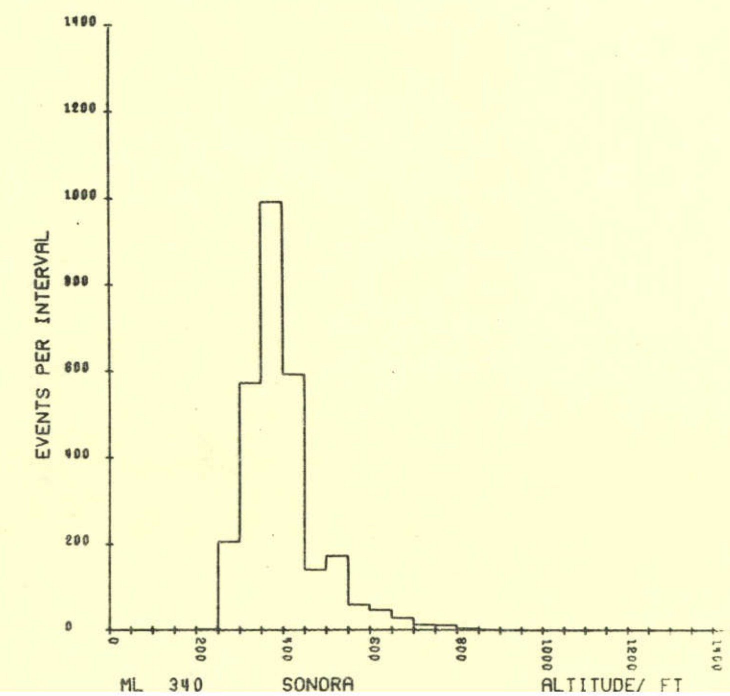

2713
EVENTS PER INTERVAL
ML 320
SONORA
SPEED IN MPH

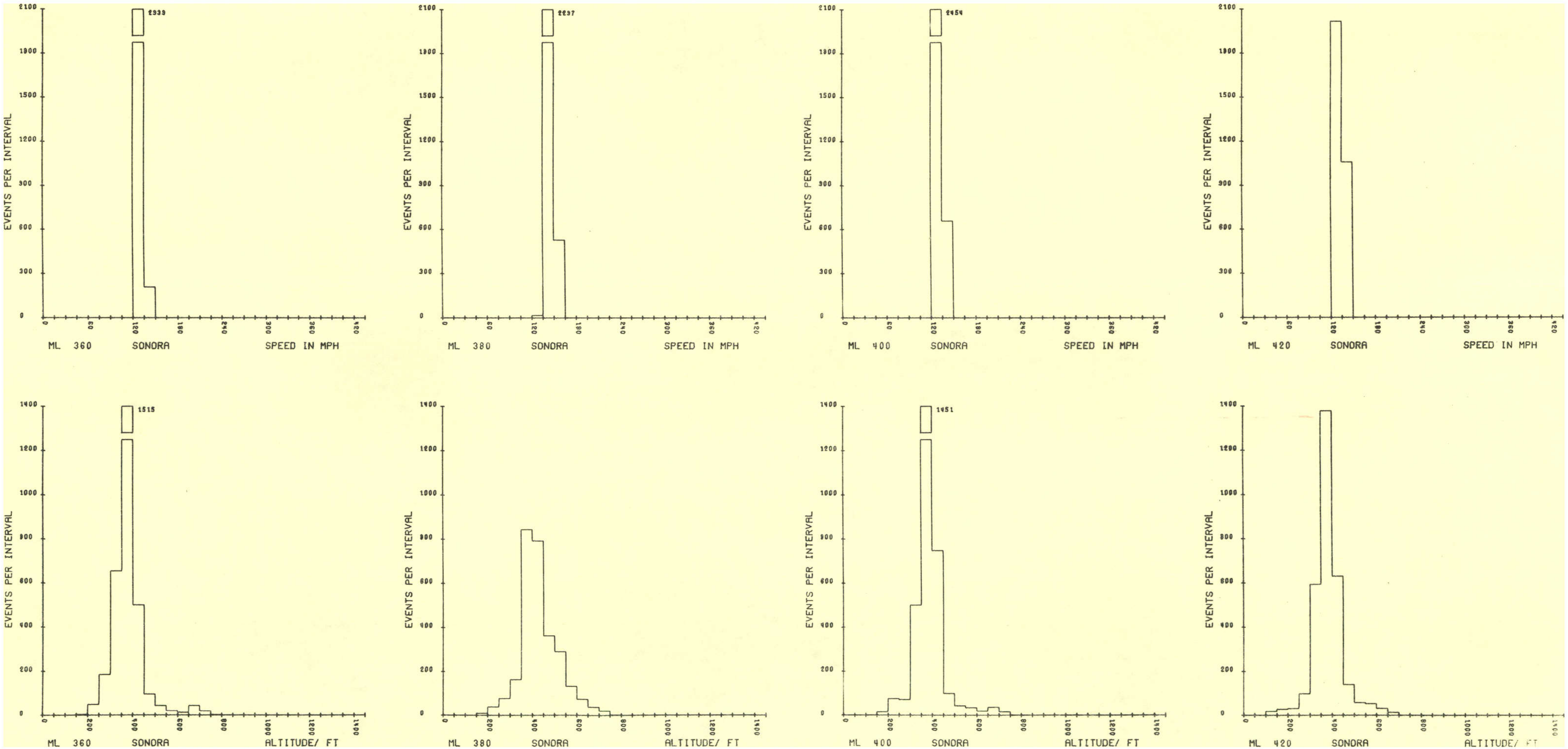

2565
EVENTS PER INTERVAL
ML 340
SONORA
SPEED IN MPH

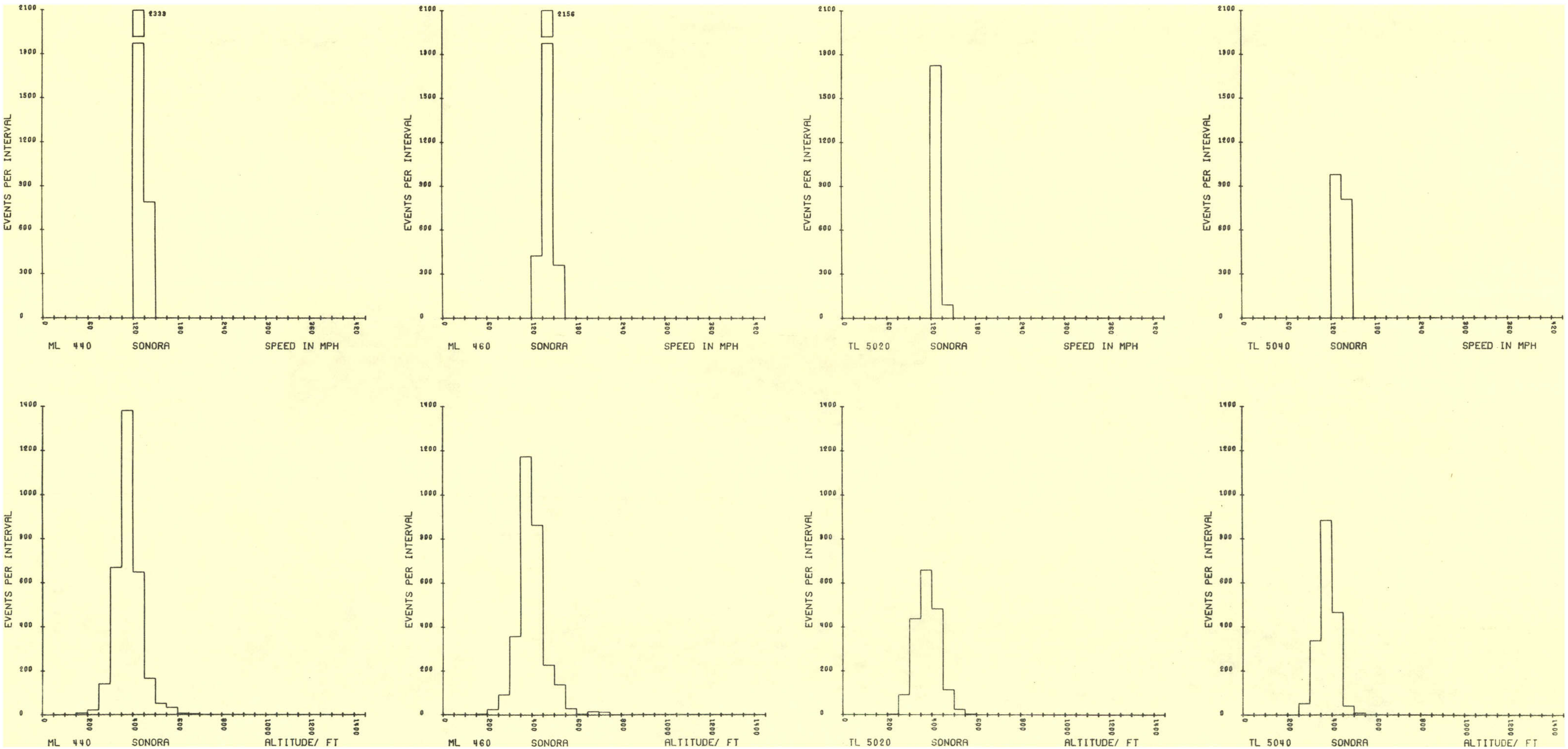

EVENTS PER INTERVAL
ML 280
SONORA
ALTITUDE/ FT

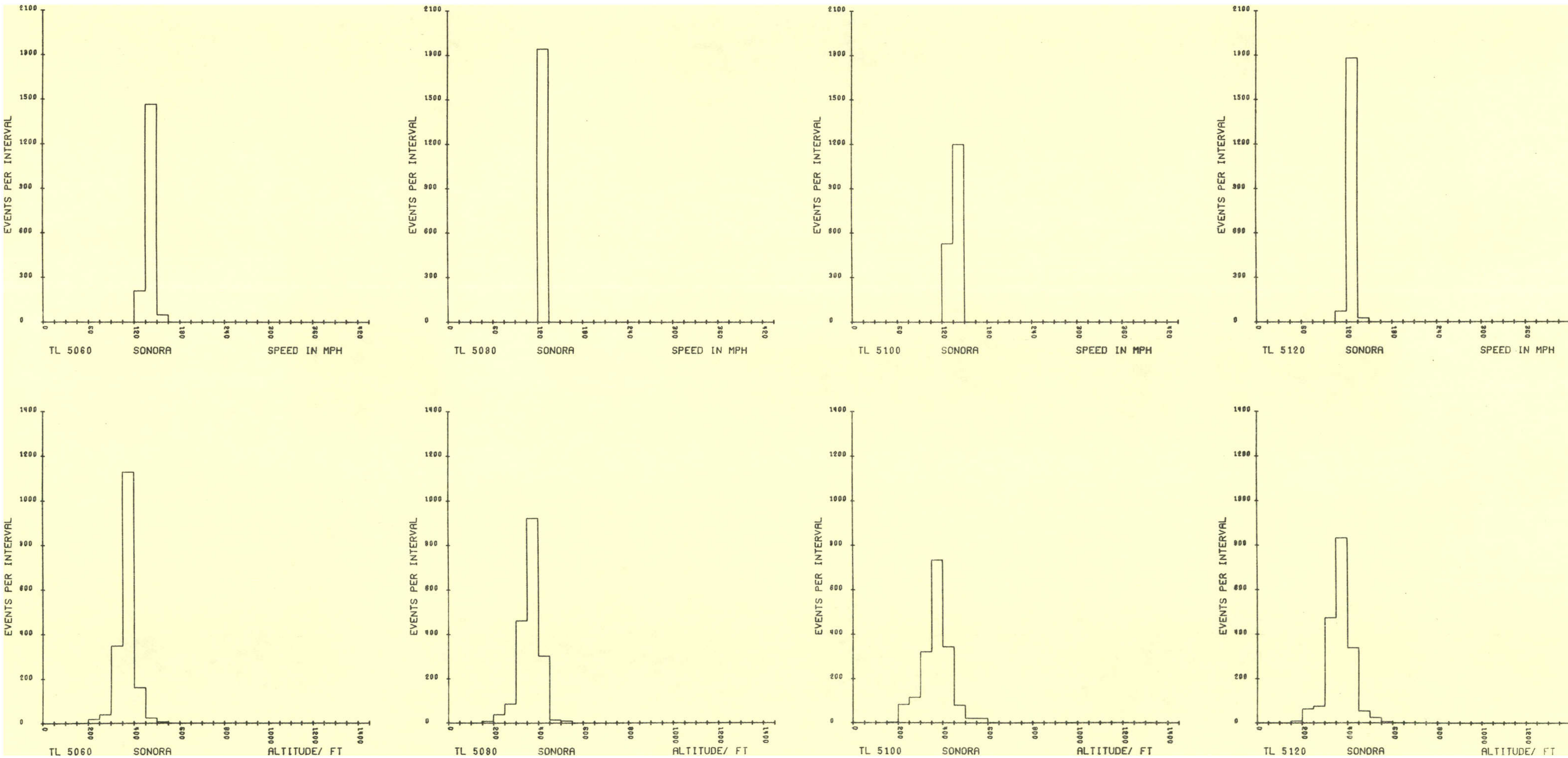

EVENTS PER INTERVAL
ML 300
SONORA
ALTITUDE/ FT

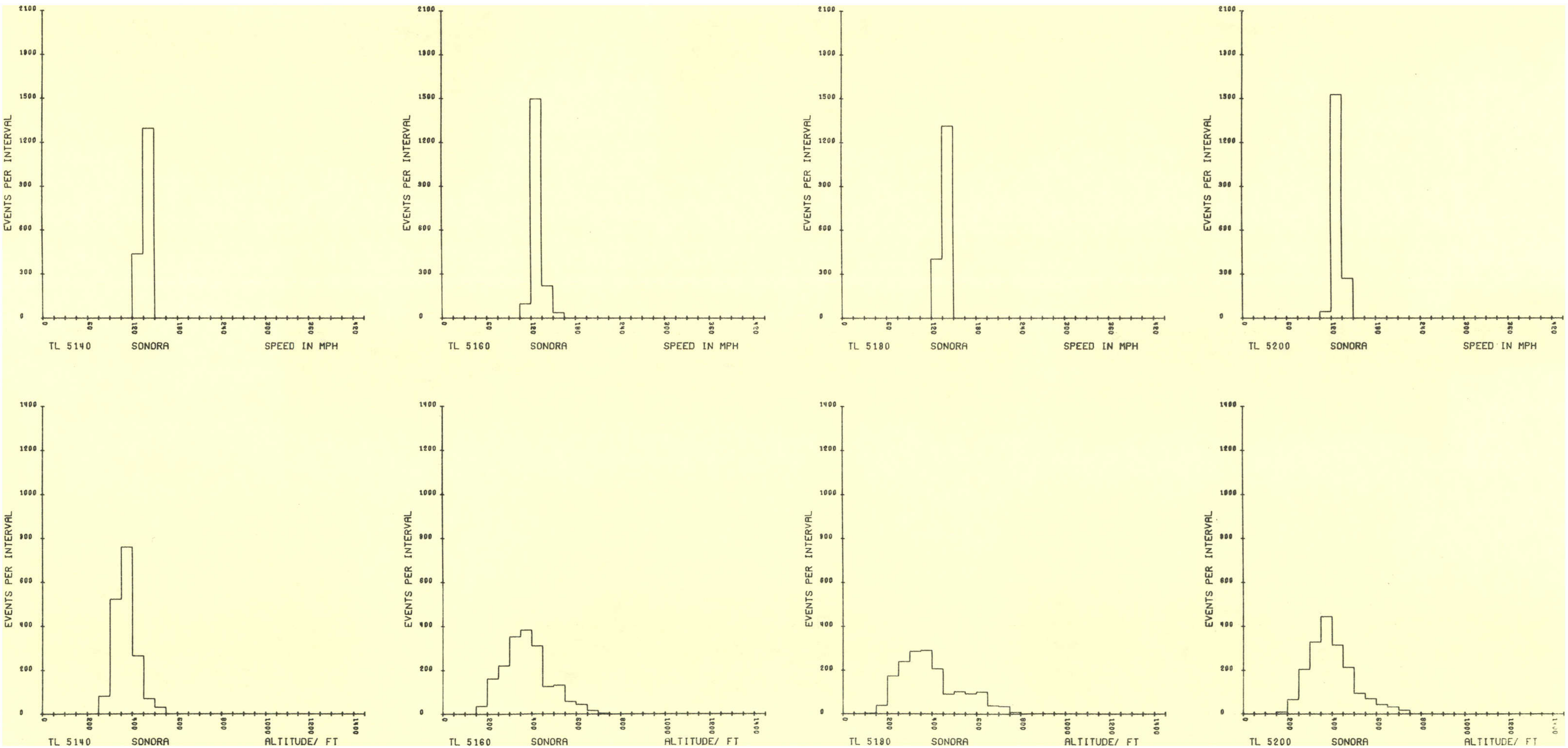

EVENTS PER INTERVAL
ML 320
SONORA
ALTITUDE/ FT


EVENTS PER INTERVAL
ML 340
SONORA
ALTITUDE/ FT


EVENTS PER INTERVAL
ML 360 SONORA SPEED IN MPH
2933
ML 380 SONORA SPEED IN MPH
2237
ML 400 SONORA SPEED IN MPH
2454
ML 420 SONORA SPEED IN MPH
ML 360 SONORA ALTITUDE/ FT
1515
ML 380 SONORA ALTITUDE/ FT
ML 400 SONORA ALTITUDE/ FT
1451
ML 420 SONORA


EVENTS PER INTERVAL
2339
ML 440 SONORA SPEED IN MPH
2156
ML 460 SONORA SPEED IN MPH
TL 5020 SONORA SPEED IN MPH
TL 5040 SONORA SPEED IN MPH
ML 440 SONORA ALTITUDE/ FT
ML 460 SONORA ALTITUDE/ FT
TL 5020 SONORA ALTITUDE/ FT
TL 5040 SONORA ALTITUDE/ FT


EVENTS PER INTERVAL
TL 5060
SONORA
SPEED IN MPH
TL 5080
SONORA
SPEED IN MPH
TL 5100
SONORA
SPEED IN MPH
TL 5120
SONORA
SPEED IN MPH
TL 5060
SONORA
ALTITUDE/ FT
TL 5080
SONORA
ALTITUDE/ FT
TL 5100
SONORA
ALTITUDE/ FT
TL 5120
SONORA
ALTITUDE/ FT


EVENTS PER INTERVAL
TL 5140 SONORA SPEED IN MPH
TL 5160 SONORA SPEED IN MPH
TL 5180 SONORA SPEED IN MPH
TL 5200 SONORA SPEED IN MPH
TL 5140 SONORA ALTITUDE/ FT
TL 5160 SONORA ALTITUDE/ FT
TL 5180 SONORA ALTITUDE/ FT
TL 5200 SONORA ALTITUDE/ FT

APPENDIX II

TAPE FORMAT STATEMENTS

A. DESCRIPTION OF DATA TAPES

A1. General

All data tapes are 9-track, 800 BPI (NRZI), odd parity, EBCDIC code. Each tape contains a gum label giving the survey project name, month and year of survey, tape type, subcontractor name, date tape created, tape reel count, tape recording characteristics, block size in Bytes and location of tape format information.

The general description for each of the tape types is as follows:

Block Number	Description
1	Format Description
2	Tape Identification
3	First Data Block
4	Second Data Block
.	.
.	.
.	Last Data Block
EOF	

A2. Raw Spectral Data Tapes

Block Size (Physical Record): 6600 characters
Logical Record, Data : 1100 characters

1. Format Description Block (Block 1)

The Format Description utilizes 4248 characters. The remaining 2352 characters of this block are blanks.

Line Number	Character Number 1234567890123456789012345678901234567890123456789012345678901234567890		
1	01 0978 (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODES)		
2			
3	RAW SPECTRAL DATA TAPE		
4			
5	FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK ON TAPE)		
6			
7	ITEM	FORMAT	DESCRIPTION
8	1	A40	QUADRANGLE NAME AS PROJECT IDENTIFICATION
9	2	A20	NAME OF SUBCONTRACTOR
10	3	!4	APPROXIMATE DATE OF SURVEY (MONTH, YEAR)

Line Number	Character Number 1234567890123456789012345678901234567890123456789012345678901234567890		
11	4	I1	AERIAL SYSTEM IDENTIFICATION CODE
12	5	A20	AIRCRAFT IDENTIFICATION BY TYPE AND FAA NUMBER
13	6	I3	BFEC CALIBRATION REPORT NUMBER
14	7	F6.3	4PI SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
15			PLACES IN SECONDS
16	8	F6.3	2PI SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
17			PLACES IN SECONDS
18	9	I3	NUMBER OF CHANNELS (0-3 MEV) FOR 4PI SYSTEM
19	10	I3	NUMBER OF CHANNELS (0-3 MEV) FOR 2PI SYSTEM
20	11	I3	NUMBER OF FLIGHT LINES ON THIS TAPE
21	12	I4	FIRST FLIGHT LINE NUMBER ON THIS TAPE
22	13	I6	FIRST RECORD NUMBER OF FIRST FLIGHT LINE
23	14	I3	JULIAN DATE (DAY OF YEAR) FIRST FLIGHT LINE WAS
24			COLLECTED
25	15-17	I4,I6,I3	REPEAT OF ITEMS 12-14 FOR SECOND FLIGHT LINE ON THIS
26			TAPE
27	*	*	*
28	*	*	*
29	*	*	*
30	306-308	I4,I6,I3	REPEAT OF ITEMS 12-14 FOR 99TH FLIGHT LINE ON THIS
31			TAPE
32			
33	FORMAT FOR RAW SPECTRAL DATA RECORD (THIRD THRU LAST BLOCK ON TAPE)		
34			
35	ITEM	FORMAT	DESCRIPTION
36	1	I1	AERIAL SYSTEM IDENTIFICATION CODE
37	2	I4	FLIGHT LINE NUMBER
38	3	I6	RECORD IDENTIFICATION NUMBER
39	4	I6	GMT TIME OF DAY (HHMMSS)
40	5	F8.4	LATITUDE TO FOUR DECIMAL PLACES IN DEGREES
41	6	F8.4	LONGITUDE TO FOUR DECIMAL PLACES IN DEGREES
42	7	F6.1	TERRAIN CLEARANCE TO ONE DECIMAL PLACE IN METERS
43	8	F7.1	TOTAL MAGNETIC FIELD INTENSITY TO ONE DECIMAL PLACE
44			IN GAMMAS
45	9	A8	SURFACE GEOLOGIC MAP UNIT CODE
46	10	I4	QUALITY FLAG CODES
47	11	F4.1	OUTSIDE AIR TEMPERATURE TO ONE DECIMAL PLACE IN
48			DEGREES CELSIUS
49	12	F5.1	OUTSIDE AIR PRESSURE TO ONE DECIMAL PLACE IN MMHG
50	13	F5.3	LIVE TIME COUNTING PERIOD TO THREE DECIMAL PLACES IN
51			SECONDS
52	14	I4	SUMMED RAW OUTPUT FROM COSMIC CHANNELS (3-6 MEV) IN
53			COUNTS
54	15	I4	RAW OUTPUT FROM CHANNEL 1 IN COUNTS
55	16	I4	RAW OUTPUT FROM CHANNEL 2 IN COUNTS
56	*	*	*
57	*	*	*
58	*	*	*
59	270	I4	RAW OUTPUT FROM CHANNEL 256 IN COUNTS
-	-	-	2352 BLANK CHARACTERS

2. Tape Identification Block (Block 2)

The information and format for this block are indicated in lines 8 through 30 of the Format Description Block A2.1, and 1396 characters are produced. The remaining 5204 characters in this block are blanks.

If fewer than 99 flight lines exist, the unused flight line information, 13 characters per flight line, is filled with 9's through the 99th flight line.

3. Raw Spectral Data Blocks

The information and format for the logical records in these blocks are indicated in lines 36 through 59 of the Format Description Block A2.1. One logical record contains 1100 characters. There are six such logical records per 6600 character physical record or block.

The 2π data logical record is recorded after the corresponding 4π data collection intervals at a frequency dependent on the 2π system data collection interval. For example, if the 4π data collection interval is 1 second and the 2π data collection interval is 10 seconds, then 10 records of 4π data are recorded followed by 1 record of the 2π data which was collected during the preceding 10 seconds. The format for the 2π data is identical to that of the 4π data, except for lines 40 through 49 of the Format Description Block given above. These variables are expressed in the 2π record as all nines in the format specified for I and F fields, and all zeros for A fields.

A3. Single Record Reduced Data Tapes

Block Size (Physical Record): 6900 characters
Logical Record, Data : 138 characters

1. Format Description Block (Block 1)

The Format Description utilizes 6768 characters. The remaining 132 characters of this block are blanks.

Line Number	Character Number 123456789012345678901234567890123456789012345678901234567890123456789012
1	02 0978 (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODES)
2	
3	SINGLE RECORD REDUCED DATA TAPE
4	
5	FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)
6	

Line Number	Character Number 1234567890123456789012345678901234567890123456789012345678901234567890123456789012		
7	ITEM	FORMAT	DESCRIPTION
8	1	A40	QUADRANGLE NAME AS PROJECT IDENTIFICATION
9	2	A20	NAME OF SUBCONTRACTOR
10	3	I4	APPROXIMATE DATE OF SURVEY (MONTH, YEAR)
11	4	I1	NUMBER OF AERIAL SYSTEMS USED TO COLLECT DATA FOR
12			THIS QUADRANGLE
13	5	I1	AERIAL SYSTEM IDENTIFICATION CODE FOR FIRST SYSTEM
14	6	A20	AIRCRAFT IDENTIFICATION BY TYPE AND FAA NUMBER FOR
15			FIRST SYSTEM
16	7	F6.1	NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
17			TERRESTRIAL POTASSIUM (K-40) TO ONE DECIMAL PLACE
18			IN CPS PER PERCENT K FOR FIRST SYSTEM
19	8	F6.1	NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
20			TERRESTRIAL URANIUM (BI-214) TO ONE DECIMAL PLACE
21			IN CPS PER PPM EQUIVALENT U
22	9	F6.1	NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
23			TERRESTRIAL THORIUM (TL-208) TO ONE DECIMAL PLACE
24			IN CPS PER PPM EQUIVALENT TH
25	10	I6	BLANK FIELD (999999)
26	11	F6.3	4PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
27			PLACES IN SECONDS FOR FIRST SYSTEM
28	12	F6.3	2PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
29			PLACES IN SECONDS FOR FIRST SYSTEM
30	13	I3	NUMBER OF CHANNELS (0-3 MEV) IN 4PI SYSTEM FOR FIRST
31			AERIAL SYSTEM
32	14	I3	NUMBER OF CHANNELS (0-3 MEV) IN 2PI SYSTEM FOR FIRST
33			AERIAL SYSTEM
34	15-24	(SAME)	REPEAT OF ITEMS 5-14 FOR SECOND AERIAL SYSTEM
35	*	*	*
36	*	*	*
37	*	*	*
38	85-94	(SAME)	REPEAT OF ITEMS 5-14 FOR NINTH AERIAL SYSTEM
39	95	I3	NUMBER OF FLIGHT LINES ON THIS TAPE
40	96	I4	FIRST FLIGHT LINE NUMBER ON THIS TAPE
41	97	I6	FIRST RECORD NUMBER OF FIRST FLIGHT LINE
42	98	I3	JULIAN DATE (DAY OF YEAR) FIRST FLIGHT-LINE DATA WAS
43			COLLECTED
44	99-101	I4,I6,I3	REPEAT OF ITEMS 96-98 FOR SECOND FLIGHT LINE ON THIS
45			TAPE
46	*	*	*
47	*	*	*
48	*	*	*
49	390-392	I4,I6,I3	REPEAT OF ITEMS 96-98 FOR 99TH FLIGHT LINE ON THIS
50			TAPE
51			
52	FORMAT FOR SINGLE		RECORD REDUCED DATA RECORD (THIRD THRU LAST BLOCK)
53			
54	ITEM	FORMAT	DESCRIPTION
55	1	I1	AERIAL SYSTEM IDENTIFICATION CODE
56	2	I4	FLIGHT LINE NUMBER
57	3	I6	RECORD IDENTIFICATION NUMBER
58	4	I6	GMT TIME OF DAY (HHMMSS)
59	5	F8.4	LATITUDE TO FOUR DECIMAL PLACES IN DEGREES

Line Number	Character Number 1234567890123456789012345678901234567890123456789012345678901234567890123456789012		
60	6	F8.4	LONGITUDE TO FOUR DECIMAL PLACES IN DEGREES
61	7	F6.1	TERRAIN CLEARANCE TO ONE DECIMAL PLACE IN METERS
62	8	F7.1	RESIDUAL (IGRF REMOVED) MAGNETIC FIELD INTENSITY
63			TO ONE DECIMAL PLACE IN GAMMAS
64	9	A8	SURFACE GEOLOGIC MAP UNIT CODE
65	10	I4	QUALITY FLAG CODES
66	11	F6.1	APPARENT CONCENTRATION OF TERRESTRIAL POTASSIUM
67			(K-40) TO ONE DECIMAL PLACE IN PERCENT K
68	12	F4.1	UNCERTAINTY IN TERRESTRIAL POTASSIUM TO ONE DECIMAL
69			PLACE IN PERCENT K
70	13	F6.1	APPARENT CONCENTRATION OF TERRESTRIAL URANIUM
71			(BI-214) TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
72	14	F4.1	UNCERTAINTY IN TERRESTRIAL URANIUM TO ONE DECIMAL
73			PLACE IN PPM EQUIVALENT U
74	15	F6.1	APPARENT CONCENTRATION OF TERRESTRIAL THORIUM
75			(TL-208) TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
76	16	F4.1	UNCERTAINTY IN TERRESTRIAL THORIUM TO ONE DECIMAL
77			PLACE IN PPM EQUIVALENT TH
78	17	F6.1	URANIUM-TO-THORIUM RATIO TO ONE DECIMAL PLACE IN
79			PPM EQUIVALENT U PER PPM EQUIVALENT TH
80	18	F6.1	URANIUM-TO-POTASSIUM RATIO TO ONE DECIMAL PLACE IN
81			PPM EQUIVALENT U PER PERCENT K
82	19	F6.1	THORIUM-TO-POTASSIUM RATIO TO ONE DECIMAL PLACE IN
83			PPM EQUIVALENT TH PER PERCENT K
84	20	F8.1	GROSS GAMMA (0.4-3.0 MEV) COUNT RATE TO ONE DECIMAL
85			PLACE IN COUNTS PER SECOND
86	21	F6.1	UNCERTAINTY IN GROSS GAMMA COUNT RATE TO ONE DECIMAL
87			PLACE IN COUNTS PER SECOND
88	22	F5.1	ATMOSPHERIC BI-214 4PI CORRECTION TO ONE DECIMAL
89			PLACE IN PPM EQUIVALENT U
90	23	F4.1	UNCERTAINTY IN ATMOSPHERIC BI-214 4PI CORRECTION
91			TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
92	24	F4.1	OUTSIDE AIR TEMPERATURE TO ONE DECIMAL PLACE IN
93			DEGREES CELSIUS
94	25	F5.1	OUTSIDE AIR PRESSURE TO ONE DECIMAL PLACE IN MMHG

2. Tape Identification Block (Block 2)

The information and format for this block are indicated in lines 8 through 49 of the Format Description Block A3.1, and 1922 characters are produced. The remaining 4978 characters of this block are blanks.

If less than nine aerial systems are used, the space allocated for additional systems is filled with 9's in the format specified for each item using I and F fields, and with zeros for A fields.

Similarly, if fewer than 99 flight lines exist, the unused flight line information, 13 characters per flight line, is filled with 9's through the 99th flight line.

3. Single Record Reduced Data Blocks

The information and format for the logical records in these blocks are indicated in lines 55 through 94 of the Format Description Block A3.1. One logical record contains 138 characters. There are 50 such logical records per 6900 character physical record or block.

The data appearing in locations specified by lines 68, 72, 76, 86 and 90 of the Format Description Block A3.1 are 9's in the format specified in each case.

A4. Statistical Analysis Tapes (Data and Summary)

File 1: Statistical Analysis Data

Block Size (Physical Record): 8000 characters
Logical Record, Data : 160 characters

1. Format Description Block (Block 1)

The Format Description utilizes 7560 characters. The remaining 440 characters are blanks.

Line Number	Character Number 123456789012345678901234567890123456789012345678901234567890123456789012		
1	03 0978 (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODES)		
2			
3	STATISTICAL ANALYSIS DATA TAPE		
4			
5	FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)		
6			
7	ITEM	FORMAT	DESCRIPTION
8	1	A40	QUADRANGLE NAME AS PROJECT IDENTIFICATION
9	2	A20	NAME OF SUBCONTRACTOR
10	3	I4	APPROXIMATE DATE OF SURVEY (MONTH, YEAR)
11	4	I1	NUMBER OF AERIAL SYSTEMS USED TO COLLECT DATA FOR
12			THIS QUADRANGLE
13	5	I1	AERIAL SYSTEM IDENTIFICATION CODE FOR FIRST SYSTEM
14	6	A20	AIRCRAFT IDENTIFICATION BY TYPE AND FAA NUMBER FOR
15			FIRST SYSTEM
16	7	F6.1	NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
17			TERRESTRIAL POTASSIUM (K-40) TO ONE DECIMAL PLACE
18			IN CPS PER PERCENT K
19	8	F6.1	NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
20			TERRESTRIAL URANIUM (BI-214) TO ONE DECIMAL PLACE
21			IN CPS PER PPM EQUIVALENT U
22	9	F6.1	NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
23			TERRESTRIAL THORIUM (TL-208) TO ONE DECIMAL PLACE
24			IN CPS PER PPM EQUIVALENT TH
25	10	I6	BLANK FIELD (999999)
26	11	F6.3	4PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
27			PLACES IN SECONDS FOR FIRST SYSTEM
28	12	F6.3	2PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
29			PLACES IN SECONDS FOR FIRST SYSTEM

Line Number	Character Number 123456789012345678901234567890123456789012345678901234567890123456789012		
30	13	I3	NUMBER OF CHANNELS (0-3 MEV) IN 4PI SYSTEM FOR FIRST
31			AERIAL SYSTEM
32	14	I3	NUMBER OF CHANNELS (0-3 MEV) IN 2PI SYSTEM FOR FIRST
33			AERIAL SYSTEM
34	15-24	(SAME)	REPEAT OF ITEMS 5-14 FOR SECOND AERIAL SYSTEM
35	*	*	*
36	*	*	*
37	*	*	*
38	85-94	(SAME)	REPEAT OF ITEMS 5-14 FOR NINTH AERIAL SYSTEM
39	95	I3	NUMBER OF FLIGHT LINES ON THIS TAPE
40	96	I4	FIRST FLIGHT LINE NUMBER ON THIS TAPE
41	97	I6	FIRST RECORD NUMBER OF FIRST FLIGHT LINE
42	98	I3	JULIAN DATE (DAY OF YEAR) FIRST FLIGHT LINE DATA WAS
43			COLLECTED
44	99-101	I4,I6,I3	REPEAT OF ITEMS 96-98 FOR SECOND FLIGHT LINE ON THIS
45			TAPE
46	*	*	*
47	*	*	*
48	*	*	*
49	390-392	I4,I6,I3	REPEAT OF ITEMS 96-98 FOR 99TH FLIGHT LINE ON THIS
50			TAPE
51			
52	FORMAT FOR STATISTICAL ANALYSIS DATA RECORD (THIRD THRU LAST BLOCK)		
53			
54	ITEM	FORMAT	DESCRIPTION
55	1	I1	AERIAL SYSTEM IDENTIFICATION CODE
56	2	I4	FLIGHT LINE NUMBER
57	3	I6	RECORD IDENTIFICATION NUMBER
58	4	I6	GMT TIME OF DAY (HHMMSS)
59	5	F8.4	LATITUDE TO FOUR DECIMAL PLACES IN DEGREES
60	6	F8.4	LONGITUDE TO FOUR DECIMAL PLACES IN DEGREES
61	7	F6.1	TERRAIN CLEARANCE TO ONE DECIMAL PLACE IN METERS
62	8	F7.1	RESIDUAL (IGRF REMOVED) MAGNETIC FIELD INTENSITY
63			TO ONE DECIMAL PLACE IN GAMMAS
64	9	A8	SURFACE GEOLOGIC MAP UNIT CODE
65	10	I5	QUALITY FLAG CODES
66	11	F6.1	AVERAGED CONCENTRATION OF TERRESTRIAL POTASSIUM
67			(K-40) TO ONE DECIMAL PLACE IN PERCENT K
68	12	F4.1	UNCERTAINTY IN TERRESTRIAL POTASSIUM TO ONE DECIMAL
69			PLACE IN PERCENT K
70	13	F5.1	POTASSIUM STANDARD DEVIATION FROM THE MEAN TO ONE
71			DECIMAL PLACE AND ALGEBRAICALLY SIGNED
72	14	F6.1	AVERAGED CONCENTRATION OF TERRESTRIAL URANIUM
73			(BI-214) TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
74	15	F4.1	UNCERTAINTY IN TERRESTRIAL URANIUM TO ONE DECIMAL
75			PLACE IN PPM EQUIVALENT U
76	16	F5.1	URANIUM STANDARD DEVIATION FROM THE MEAN TO ONE
77			DECIMAL PLACE AND ALGEBRAICALLY SIGNED
78	17	F6.1	AVERAGED CONCENTRATION OF TERRESTRIAL THORIUM
79			(TL-208) TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
80	18	F4.1	UNCERTAINTY IN TERRESTRIAL THORIUM TO ONE DECIMAL
81			PLACE IN PPM EQUIVALENT TH

Line Number	Character Number 123456789012345678901234567890123456789012345678901234567890123456789012		
82	19	F5.1	THORIUM STANDARD DEVIATION FROM THE MEAN TO ONE
83			DECIMAL PLACE AND ALGEBRAICALLY SIGNED
84	20	F8.1	GROSS GAMMA (0.4-3.0 MEV) COUNT RATE TO ONE DECIMAL
85			PLACE IN COUNTS PER SECOND
86	21	F6.1	UNCERTAINTY IN GROSS GAMMA COUNT RATE TO ONE DECIMAL
87			PLACE IN COUNTS PER SECOND
88	22	F5.1	ATMOSPHERIC BI-214 4PI CORRECTION TO ONE DECIMAL
89			PLACE IN PPM EQUIVALENT U
90	23	F4.1	UNCERTAINTY IN ATMOSPHERIC BI-214 4PI CORRECTION
91			TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
92	24	F6.1	AVERAGED URANIUM-TO-THORIUM RATIO TO ONE DECIMAL
93			PLACE IN PPM EQUIVALENT U PER PPM EQUIVALENT TH
94	25	F5.1	URANIUM-TO-THORIUM RATIO STANDARD DEVIATION FROM THE
95			MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED
96	26	F6.1	AVERAGED URANIUM-TO-POTASSIUM RATIO TO ONE DECIMAL
97			PLACE IN PPM EQUIVALENT U PER PERCENT K
98	27	F5.1	URANIUM-TO-POTASSIUM RATIO STANDARD DEVIATION FROM
99			THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED
100			SIGNED
101	28	F6.1	AVERAGED THORIUM-TO-POTASSIUM RATIO TO ONE DECIMAL
102			PLACE IN PPM EQUIVALENT TH PER PERCENT K
103	29	F5.1	THORIUM-TO-POTASSIUM RATIO STANDARD DEVIATION FROM
104			THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY
105			SIGNED

2. Tape Identification Block (Block 2)

The information and format for this block are indicated in lines 8 through 49 of the Format Description Block A4.1, and 1922 characters are produced. The remaining 6078 characters of this block are blanks.

If less than nine aerial systems are used, the space allocated for additional systems is filled with 9's in the format specified for each item using I and F fields, and with zeros for A fields.

Similarly, if fewer than 99 flight lines exist, the unused flight line information, 13 characters per flight line, is filled with 9's through the 99th flight line.

3. Statistical Analysis Data Blocks

The information and format for the logical records in these blocks are indicated in lines 55 through 103 of the Format Description Block A4.1. One logical record contains 160 characters. There are 50 such logical records per 8000 character physical record or block.

The data appearing in locations specified by lines 68, 74, 80, 86 and 90 of the Format Description Block A4.1 are 9's in the format specified in each case.

File 2: <u>Statistical Analysis Summary</u>

Block Size (Physical Record): 7000 characters
Logical Record (Data) : 140 characters

1. <u>Format Description Block (Block 1)</u>

The Format Description utilizes 4320 characters. The remaining 2680 characters are blanks.

Line Number	Character Number 123456789012345678901234567890123456789012345678901234567890123456789012		
1	05 0978 (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODE)		
2			
3	STATISTICAL ANALYSIS SUMMARY TAPE (OR FILE)		
4			
5	FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)		
6			
7	ITEM	FORMAT	DESCRIPTION
8	1	A40	QUADRANGLE NAME AS PROJECT IDENTIFICATION
9	2	A20	NAME OF SUBCONTRACTOR
10	3	I4	APPROXIMATE DATE OF SURVEY (MONTH, YEAR)
11	4	I6	NUMBER OF GEOLOGIC MAP UNITS USED FOR THIS
12			QUADRANGLE
13			
14	FORMAT FOR STATISTICAL ANALYSIS SUMMARY DATA RECORD (THIRD THRU LAST		
15	BLOCK)		
16			
17	ITEM	FORMAT	DESCRIPTION
18	1	A8	SURFACE GEOLOGIC MAP UNIT IDENTIFYING CODE
19	2	I6	TOTAL RECORDS FOR GEOLOGIC MAP UNIT
20	3	I6	NUMBER OF POTASSIUM RECORDS COMPUTED FOR GEOLOGIC
21			UNIT
22	4	F6.1	POTASSIUM CONCENTRATION MEAN TO ONE DECIMAL
23			PLACE IN PERCENT K
24	5	F6.1	POTASSIUM CONCENTRATION STANDARD DEVIATION TO ONE
25			DECIMAL PLACE IN PERCENT K
26	6	A3	POTASSIUM CONCENTRATION DISTRIBUTION CODE
27	7	I6	NUMBER OF URANIUM RECORDS COMPUTED FOR GEOLOGIC UNIT
28	8	F6.1	URANIUM CONCENTRATION MEAN TO ONE DECIMAL PLACE
29			IN PPM EQUIVALENT U
30	9	F6.1	URANIUM CONCENTRATION STANDARD DEVIATION TO ONE
31			DECIMAL PLACE IN PPM EQUIVALENT U
32	10	A3	URANIUM CONCENTRATION DISTRIBUTION CODE
33	11	I6	NUMBER OF THORIUM RECORDS COMPUTED FOR GEOLOGIC UNIT
34	12	F6.1	THORIUM CONCENTRATION MEAN TO ONE DECIMAL PLACE IN
35			PPM EQUIVALENT TH
36	13	F6.1	THORIUM CONCENTRATION STANDARD DEVIATION TO ONE
37			DECIMAL PLACE IN PPM EQUIVALENT TH

Line Number	Character Number 123456789012345678901234567890123456789012345678901234567890123456789012		
38	14	A3	THORIUM CONCENTRATION DISTRIBUTION CODE
39	15	I6	NUMBER OF URANIUM-TO-THORIUM RATIO RECORDS COMPUTED
40			FOR GEOLOGIC UNIT
41	16	F6.1	URANIUM-TO-THORIUM RATIO MEAN TO ONE DECIMAL PLACE
42			IN PPM EQUIVALENT U PER PPM EQUIVALENT TH
43	17	F6.1	URANIUM-TO-THORIUM RATIO STANDARD DEVIATION TO ONE
44			DECIMAL PLACE IN PPM EQUIVALENT U PER PPM EQUIVALENT
45			TH
46	18	A3	URANIUM-TO-THORIUM RATIO DISTRIBUTION CODE
47	19	I6	NUMBER OF URANIUM-TO-POTASSIUM RATIO RECORDS
48			COMPUTED FOR GEOLOGIC UNIT
49	20	F6.1	URANIUM-TO-POTASSIUM RATIO MEAN TO ONE DECIMAL PLACE
50			IN PPM EQUIVALENT U PER PERCENT K
51	21	F6.1	URANIUM-TO-POTASSIUM RATIO STANDARD DEVIATION TO ONE
52			DECIMAL PLACE IN PPM EQUIVALENT U PER PERCENT K
53	22	A3	URANIUM-TO-POTASSIUM RATIO DISTRIBUTION CODE
54	23	I6	NUMBER OF THORIUM-TO-POTASSIUM RATIO RECORDS
55			COMPUTED FOR GEOLOGIC UNIT
56	24	F6.1	THORIUM-TO-POTASSIUM RATIO MEAN TO ONE DECIMAL PLACE
57			IN PPM EQUIVALENT TH PER PERCENT K
58	25	F6.1	THORIUM-TO-POTASSIUM RATIO STANDARD DEVIATION TO ONE
59			DECIMAL PLACE IN PPM EQUIVALENT TH PER PERCENT K
60	26	A3	THORIUM-TO-POTASSIUM RATIO DISTRIBUTION CODE

2. <u>Tape Identification Block (Block 2)</u>

The information and format for this block are indicated in lines 8 through 11 of the Format Description Block A6.1, and 70 characters are produced. The remaining 6930 characters of this block are blanks.

3. <u>Statistical Analysis Summary Data Blocks</u>

The information and format for the logical records in these blocks are indicated in lines 18 through 60 of the Format Description Block A6.1. One logical record contains 140 characters. There are 50 such logical records per 7000 character physical record or block.

A5. <u>Magnetic Data Tapes</u>

Block Size (Physical Record): 8000 characters
Logical Record (Data) : 80 characters

1. <u>Format Description Block (Block 1)</u>

The Format Description utilizes 3384 characters. The remaining 4616 characters are blanks.

Line Number	Character Number 123456789012345678901234567890123456789012345678901234567890123456789012		
1	04 0978 (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODES)		
2			
3	MAGNETIC DATA TAPE		
4			
5	FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)		
6			
7	ITEM	FORMAT	DESCRIPTION
8	1	A40	QUADRANGLE NAME AS PROJECT IDENTIFICATION
9	2	A20	NAME OF SUBCONTRACTOR
10	3	I4	APPROXIMATE DATE OF SURVEY (MONTH, YEAR)
11	4	I3	NUMBER OF FLIGHT LINES ON THIS TAPE
12	5	I4	FIRST FLIGHT LINE ON THIS TAPE
13	6	I6	FIRST RECORD NUMBER OF FIRST FLIGHT LINE
14	7	I3	JULIAN DATE (DAY OF YEAR) FIRST FLIGHT LINE DATA WAS
15			COLLECTED
16	8	F8.4	LATITUDE OF GROUND BASE STATION TO FOUR DECIMAL
17			PLACES IN DEGREES FOR FIRST FLIGHT LINE
18	9	F8.4	LONGITUDE OF GROUND BASE STATION TO FOUR DECIMAL
19			PLACES IN DEGREES FOR FIRST FLIGHT LINE
20	10-14	(SAME)	REPEAT OF ITEMS 5-9 FOR SECOND FLIGHT LINE ON THIS
21			TAPE
22	*	*	*
23	*	*	*
24	*	*	*
25	495-499	(SAME)	REPEAT OF ITEMS 5-9 FOR 99TH FLIGHT LINE ON THIS
26			TAPE
27			
28	FORMAT FOR MAGNETIC DATA RECORD (THIRD THRU LAST BLOCK)		
29			
30	ITEM	FORMAT	DESCRIPTION
31	1	I1	AERIAL SYSTEM IDENTIFICATION CODE
32	2	I4	FLIGHT LINE NUMBER
33	3	I6	RECORD IDENTIFICATION NUMBER
34	4	I6	GMT TIME OF DAY (HHMMSS)
35	5	F8.4	LATITUDE TO FOUR DECIMAL PLACES IN DEGREES
36	6	F8.4	LONGITUDE TO FOUR DECIMAL PLACES IN DEGREES
37	7	F6.1	TERRAIN CLEARANCE TO ONE DECIMAL PLACE IN METERS
38	8	F5.1	OUTSIDE AIR PRESSURE TO ONE DECIMAL PLACE IN MMHG
39	9	A8	SURFACE GEOLOGIC MAP UNIT CODE
40	10	F7.1	TOTAL MAGNETIC FIELD INTENSITY TO ONE DECIMAL PLACE
41			IN GAMMAS
42	11	F7.1	RESIDUAL (IGRF REMOVED) MAGNETIC FIELD INTENSITY
43			TO ONE DECIMAL PLACE IN GAMMAS
44	12	F7.1	DIURNAL MAGNETIC INTENSITY VARIATION TO ONE DECIMAL
45			PLACE IN GAMMAS
46	13	F7.1	MAGNETIC DEPTH-TO-BASEMENT TO ONE DECIMAL PLACE
47			IN METERS (IF REQUIRED)

2. Tape Identification Block (Block 2)

The information and format for this block are indicated in lines 8 through 25 of the Format Description Block A5.1, and 2938 characters are produced. The remaining 5062 characters of this block are blanks.

If fewer than 99 flight lines exist, the unused flight line information, 29 characters per flight line, is filled with 9's through the 99th flight line in the format indicated.

3. Magnetic Data Blocks

The information and format for the logical records in these blocks are indicated in lines 31 through 46 of the Format Description Block A5.1. One logical record contains 80 characters. There are 100 such logical records per 8000 character physical record or block.

If the magnetic depth-to-basement is not required, this item is expressed as 99999.9.

B. DESCRIPTION OF LISTINGS

B1. Single record reduced data listings: include the following information on Microfiche:

ITEM	DESCRIPTION
REC	Sequential record number
Lat	Location Y in latitude
Long	Location X in longitude
RMag	Residual magnetic field, gammas
Alt	Surface altitude
GEO UNIT	Geologic Type
AKUT	A=Altitude; K=Potassium; U=Uranium T=Thorium - Results of statistical adequacy test
COS	Cosmic c/s
BiAir	Airborne ^{214}Bi, 4π data
GC	Gross count, .4 MeV - 2.8 MeV
Tℓ	^{208}Tℓ c/s
Bi	^{214}Bi c/s
K	^{40}K c/s
BI:Tℓ	Ratio
BI:k	Ratio
Tℓ:K	Ratio
TEMP	Outside Air Temperature (^{o}C)
BP	Atmospheric Pressure (In. Hg)

B2. Averaged record data listings: include the following information on Microfiche:

ITEM	DESCRIPTION
REC	Sequential Record number
GEO UNIT	Geologic type
AKUT	A=Altitude; K=Potassium; U=Uranium; T=Thorium - Results of statistical adequacy test
Long	Longitude of X location of geologic type
Lat	latitude of Y location of geologic type
RMag	Residual magnetic field, gammas
COS	Cosmic, 4π
BiAir	Atmospheric Bi, 4π
GC	Gross count, c/s

ITEM	DESCRIPTION
Tℓ	Tℓ value, c/s
Rank	Tℓ standard deviation rank
Bi	Bi value, c/s
Rank	Bi standard deviation rank
K	K value, c/s
Rank	K standard deviation rank
Bi/Tℓ	Ratio value
Rank	Bi/Tℓ standard deviation rank
Bi/K	Ratio value
Rank	Bi/K standard deviation rank
Tℓ/K	Ratio value
Rank	Tℓ/K standard deviation rank

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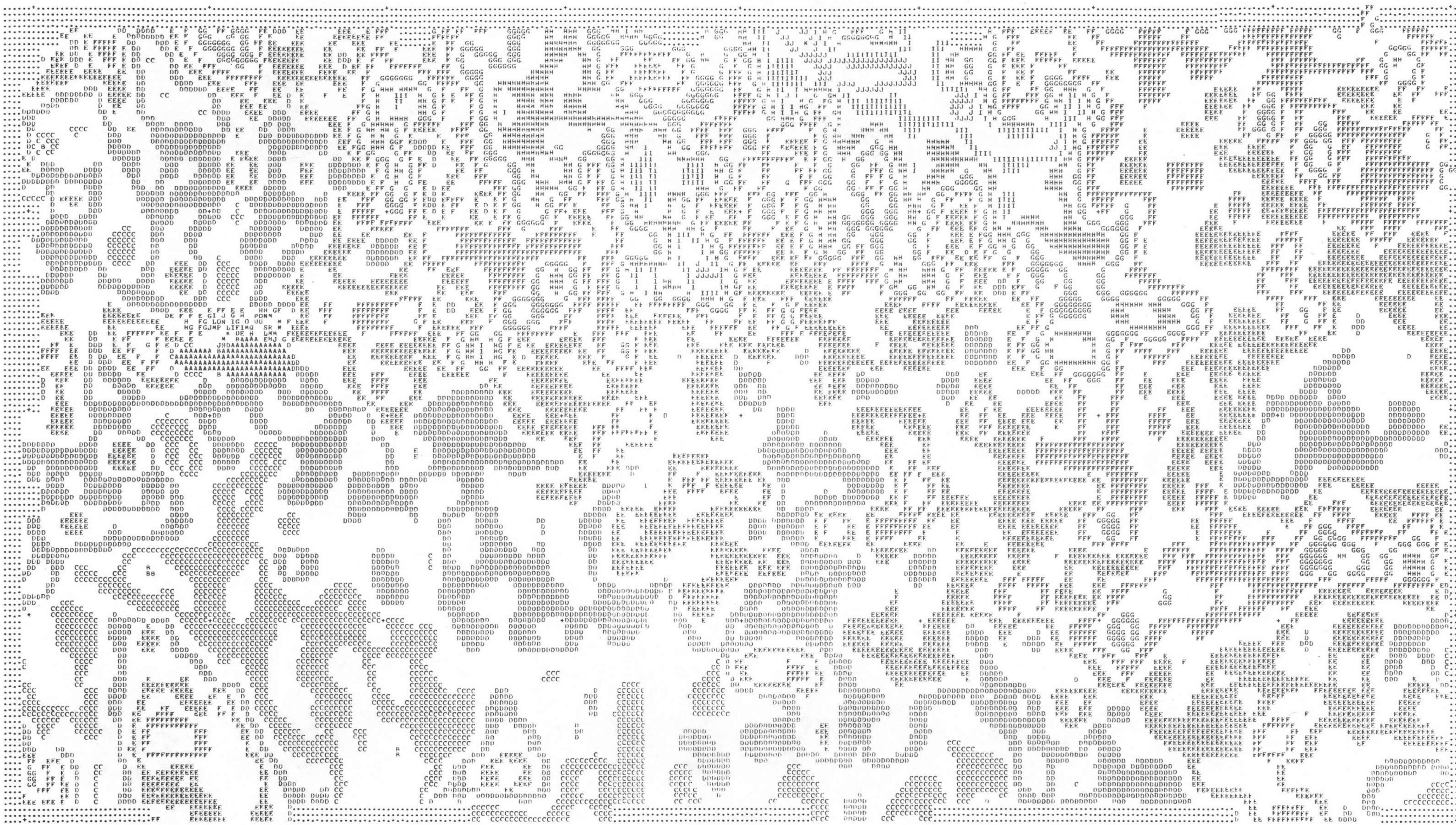
REC	GEOUNIT	AKUI	LAT	LONG	RMAG	COS	GC	BIATR	ALT	TEMP	BP	TL	BI	K	BI/TL	BI/K	TL/K
1001	ZNA	0000	30.0194	102.0280	-43.6	38	1281	14.1	468	27.7	694.4	3.8	2.3	0.3	0.61	6.81	11.22
1002	ZNA	0110	30.0194	102.0274	-166.1	12	22	14.1	468	28.9	686.8	0.3	-0.3	0.0	0.00	0.00	5.59
1003	ZNA	0100	30.0194	102.0268	-165.3	60	1529	14.1	409	29.0	686.3	2.1	5.4	0.1	2.57	44.11	17.14
1004	ZNA	0000	30.0193	102.0262	-165.3	46	1773	14.1	406	29.0	689.4	2.1	5.6	0.4	2.68	14.90	5.56
1005	ZNA	0100	30.0193	102.0256	-165.1	47	1850	14.1	402	29.0	687.3	3.4	6.0	0.1	1.78	53.39	29.92
1006	ZNA	0000	30.0193	102.0250	-165.1	49	1811	14.1	402	29.0	688.3	2.7	4.6	0.5	1.73	8.48	4.92
1007	ZNA	0000	30.0193	102.0244	-162.9	56	1882	14.1	390	29.0	690.4	3.5	4.7	0.4	1.35	11.32	8.36
1008	ZNA	0000	30.0193	102.0238	-166.6	43	1952	14.1	384	29.0	690.4	2.0	6.9	0.5	3.51	14.99	4.27
1009	ZNA	0000	30.0192	102.0232	-166.9	55	1868	14.1	376	29.1	689.4	3.9	4.8	0.5	1.23	9.62	7.84
1010	ZNA	0000	30.0192	102.0226	-161.2	51	2043	14.1	375	29.2	688.3	5.9	4.7	0.4	0.81	10.55	13.09
1011	ZNA	0000	30.0192	102.0221	-159.7	33	1957	14.1	374	28.9	688.8	5.0	5.0	0.9	0.98	5.34	5.43
1012	ZNA	0000	30.0192	102.0215	-158.7	39	1922	14.1	376	29.0	689.9	5.2	4.7	0.4	0.91	12.55	13.72
1013	ZNA	0000	30.0192	102.0209	-157.5	38	2051	14.1	377	29.0	690.4	5.3	3.8	0.7	0.71	5.14	7.24
1014	ZNA	0000	30.0191	102.0203	-156.0	52	2247	14.1	382	29.0	689.4	4.5	5.3	0.6	1.19	8.85	7.44
1015	ZNA	0000	30.0191	102.0197	-156.0	47	2097	14.1	385	29.0	689.4	4.1	4.7	0.8	1.17	5.73	4.91
1016	ZNA	0000	30.0191	102.0191	-154.5	48	2012	14.1	388	29.0	689.9	4.9	4.0	0.6	0.82	7.25	8.89
1017	ZNA	0000	30.0191	102.0185	-152.8	53	2230	14.1	397	29.0	689.9	4.1	6.1	0.8	1.51	7.62	5.03
1018	ZNA	0000	30.0191	102.0179	-152.3	47	2147	14.1	402	29.0	688.8	5.6	4.5	0.7	0.81	6.23	7.73
1019	ZNA	0000	30.0190	102.0173	-151.0	43	2422	14.1	407	29.0	687.3	5.2	6.5	0.6	1.26	11.82	9.40
1020	ZNA	0000	30.0190	102.0167	-150.8	47	2477	14.1	404	28.9	688.8	4.8	7.3	0.5	1.54	14.96	9.71
1021	ZNA	0000	30.0190	102.0161	-151.1	34	2688	14.1	404	29.0	688.8	6.2	6.9	0.7	1.12	9.92	8.87
1022	ZNA	0000	30.0190	102.0155	-149.3	61	2546	14.1	390	29.0	691.9	5.0	7.0	0.7	1.40	10.60	7.60
1023	ZNA	0000	30.0190	102.0149	-150.8	58	2812	14.1	377	29.0	689.4	4.9	7.1	0.6	1.45	12.89	8.89
1024	ZNA	0000	30.0189	102.0144	-146.8	39	2647	14.1	359	29.0	687.3	4.5	9.0	0.3	2.02	26.03	12.91
1025	ZNA	0000	30.0189	102.0138	-146.4	56	2690	14.1	361	28.9	689.9	2.7	9.9	0.2	3.73	42.24	11.33
1026	ZNA	0000	30.0189	102.0132	-144.9	57	2808	14.1	364	28.8	688.3	5.9	9.1	0.6	1.55	14.39	9.29
1027	ZNA	0000	30.0189	102.0126	-144.9	44	2537	14.1	368	28.8	688.8	3.8	5.8	0.6	1.55	9.88	6.38
1028	ZNA	0000	30.0188	102.0120	-143.1	54	2574	29.0	361	28.8	688.3	3.5	5.8	0.9	1.67	6.51	3.90
1029	ZNA	0000	30.0188	102.0114	-142.2	57	2402	29.0	358	28.8	690.4	4.9	5.3	1.1	1.09	4.66	4.29
1030	ZNA	0000	30.0188	102.0108	-141.9	56	2415	29.0	353	28.8	689.9	5.6	5.1	0.6	0.91	8.07	8.85
1031	ZNA	0000	30.0188	102.0102	-139.9	50	2279	29.0	354	28.8	690.4	5.5	4.9	0.7	0.89	7.04	7.87
1032	ZNA	0000	30.0188	102.0096	-139.2	54	2483	29.0	361	28.8	690.9	5.3	4.8	1.0	0.90	4.91	5.43
1033	ZNA	0000	30.0187	102.0090	-139.5	54	2439	29.0	366	28.8	688.3	3.2	5.7	0.9	1.77	6.65	3.76
1034	ZNA	0000	30.0187	102.0084	-138.5	53	2523	29.0	360	28.9	690.4	4.3	5.6	0.9	1.30	6.26	4.83
1035	ZNA	0000	30.0187	102.0078	-138.0	50	2358	29.0	353	28.8	690.4	4.3	6.0	0.7	1.38	8.90	6.44
1036	ZNA	0000	30.0187	102.0072	-136.0	53	2435	29.0	357	28.9	688.8	3.1	5.8	0.7	1.87	8.08	4.31
1037	ZNA	0000	30.0187	102.0067	-135.8	55	2304	29.6	359	28.9	690.4	3.5	6.4	0.6	1.84	10.34	5.62
1038	ZNA	0000	30.0186	102.0061	-134.5	35	2379	29.6	373	28.8	689.9	2.7	6.7	0.8	2.50	7.86	3.14
1039	ZNA	0000	30.0186	102.0055	-134.5	41	2340	29.6	383	29.0	688.3	5.7	6.1	0.6	1.07	10.20	9.53
1040	ZNA	0000	30.0186	102.0049	-132.5	40	2160	29.6	395	28.8	689.4	4.3	6.5	0.6	1.50	11.40	7.59
1041	ZNA	0000	30.0186	102.0043	-136.8	39	2218	29.6	397	29.0	690.9	5.3	6.1	0.4	1.14	15.25	13.36
1042	ZNA	0000	30.0186	102.0037	-131.1	52	2290	29.6	395	28.9	689.9	3.8	7.3	0.4	1.94	16.70	8.61
1043	ZNA	0000	30.0185	102.0031	-130.8	38	2248	29.6	361	29.0	690.4	4.6	5.5	0.9	1.20	6.32	5.26
1044	ZNA	0000	30.0185	102.0025	-130.8	42	2251	29.6	379	28.9	690.9	5.3	4.2	0.9	0.79	4.70	5.92
1045	KBO	0000	30.0185	102.0019	-129.4	38	2149	29.6	379	28.9	689.9	4.9	5.9	0.7	1.21	9.07	7.50
1046	KBO	0000	30.0185	102.0013	-126.9	51	2384	29.4	379	28.9	690.4	3.5	6.7	0.7	1.90	9.89	5.19
1047	KBO	0000	30.0185	102.0007	-126.9	44	1990	29.4	391	28.7	689.4	3.5	5.4	0.6	1.54	9.80	6.35
1048	KBO	0000	30.0184	102.0001	-123.1	38	2314	29.4	409	28.7	689.9	5.3	6.2	0.7	1.17	9.52	8.14
1049	KBO	0000	30.0184	101.9995	-122.9	39	2233	29.4	415	28.8	691.9	4.2	6.1	0.6	1.46	10.03	6.86
1050	KBO	0000	30.0184	101.9989	-122.9	55	1988	29.4	415	28.8	688.8	4.8	4.1	0.4	0.87	9.91	11.37
1051	KBO	0000	30.0184	101.9984	-122.2	47	1955	29.4	415	28.8	690.4	4.2	4.3	0.6	1.02	6.78	6.64
1052	KBO	0000	30.0184	101.9978	-119.7	52	1913	29.4	431	28.7	690.4	6.3	4.4	0.5	0.69	8.23	11.87
1053	KBO	0000	30.0183	101.9972	-118.0	40	1770	29.4	450	28.8	690.4	3.1	4.0	0.7	1.30	5.59	4.31
1054	QAL	0000	30.0183	101.9966	-116.0	51	1725	29.4	464	28.7	690.9	6.2	4.9	0.2	0.79	23.93	30.17
1055	QAL	0000	30.0183	101.9960	-115.7	59	1641	32.4	468	28.6	690.9	4.1	3.0	0.4	0.75	8.26	11.05
1056	QAL	0000	30.0183	101.9954	-115.7	50	1566	32.4	464	28.5	690.4	2.7	4.4	0.2	1.67	27.19	16.28
1057	QAL	0000	30.0182	101.9948	-117.8	40	1376	32.4	470	28.6	691.4	3.6	2.1	0.6	0.59	3.76	6.37

SONORA MAPLINE 20

REC	GEOUNIT	AKUI	LAT	LONG	RMAG	COS	GC	BIATR	TL RANK	BI RANK	K RANK	BI/TL RANK	BI/K RANK	TL/K RANK
1001	ZNA	0000	30.0194	102.0280	-43.6	38	1281	14.1	3.8+ 0	2.3+ 0	0.3- 0	0.61+ 0	6.81+ 0	11.22+ 0
1002	ZNA	0110	30.0194	102.0274	-166.1	12	22	14.1	0.3- 2	-0.3- 2	0.0- 1	0.00- 1	0.00- 1	5.59- 1
1003	ZNA	0000	30.0194	102.0268	-165.3	60	1529	14.1	2.1- 1	5.4+ 3	0.1- 1	2.57+ 5	44.11+10	17.14+ 2
1004	ZNA	0000	30.0193	102.0262	-165.3	46	1773	14.1	2.4- 0	4.5+ 2	0.3- 0	1.91+ 3	17.85+ 3	9.36+ 0
1005	ZNA	0000	30.0193	102.0256	-165.1	47	1850	14.1	2.6- 0	5.1+ 2	0.3- 0	1.98+ 3	17.17+ 3	8.67- 0
1006	ZNA	0000	30.0193	102.0250	-165.1	49	1811	14.1	2.8- 0	5.4+ 3	0.4- 0	1.89+ 3	14.17+ 2	7.49- 0
1007	ZNA	0000	30.0193	102.0244	-162.9	56	1882	14.1	3.1- 0	5.3+ 3	0.4- 0	1.69+ 2	12.69+ 1	7.49- 0
1008	ZNA	0000	30.0193	102.0238	-166.6	43	1952	14.1	3.5- 0	5.4+ 3	0.5- 0	1.54+ 2	11.27+ 1	7.30- 0
1009	ZNA	0000	30.0192	102.0232	-166.9	55	1868	14.1	4.0+ 0	5.2+ 2	0.5+ 0	1.29+ 1	9.93+ 1	7.69- 0
1010	ZNA	0000	30.0192	102.0226	-161.2	51	2043	14.1	4.6+ 0	5.0+ 2	0.6+ 0	1.09+ 1	8.98+ 0	8.25- 0
1011	ZNA	0000	30.0192	102.0221	-159.7	33	1957	14.1	4.9+ 0	4.8+ 2	0.6+ 0	0.99+ 1	7.98+ 0	8.04- 0
1012	ZNA	0000	30.0192	102.0215	-158.7	39	1922	14.1	5.0+ 0	4.7+ 2	0.6+ 0	0.93+ 0	7.54+ 0	8.10- 0
1013	ZNA	0000	30.0192	102.0209	-157.5	38	2051	14.1	4.9+ 0	4.6+ 2	0.6+ 0	0.93+ 0	7.07+ 0	7.63- 0
1014	ZNA	0000	30.0191	102.0203	-156.0	52	2247	14.1	4.7+ 0	4.7+ 2	0.7+ 0	1.00+ 1	7.06+ 0	7.05- 0
1015	ZNA	0000	30.0191	102.0197	-156.0	47	2097	14.1	4.6+ 0	4.7+ 2	0.7+ 0	1.03+ 1	6.94+ 0	6.75- 0
1016	ZNA	0000	30.0191	102.0191	-154.5	48	2012	14.1	4.7+ 0	4.9+ 2	0.7+ 0	1.05+ 1	7.12+ 0	6.76- 0
1017	ZNA	0000	30.0191	102.0185	-152.8	53	2230	14.1	4.7+ 0	5.3+ 3	0.7+ 0	1.13+ 1	7.82+ 0	6.92- 0
1018	ZNA	0000	30.0191	102.0179	-152.3	47	2147	14.1	5.0+ 0	5.6+ 3	0.7+ 0	1.13+ 1	8.54+ 0	7.53- 0
1019	ZNA	0000	30.0190	102.0173	-151.0	43	2422	14.1	5.1+ 0	6.2+ 3	0.6+ 0	1.20+ 1	9.80+ 1	8.16- 0
1020	ZNA	0000	30.0190	102.0167	-150.8	47	2477	14.1	5.2+ 1	6.6+ 4	0.6+ 0	1.27+ 1	10.77+ 1	8.47- 0
1021	ZNA	0000	30.0190	102.0161	-151.1	34	2688	14.1	5.3+ 1	7.0+ 4	0.6+ 0	1.32+ 1	11.71+ 1	8.86- 0
1022	ZNA	0000	30.0190	102.0155	-149.3	61	2546	14.1	5.0+ 0	7.4+ 4	0.6+ 0	1.50+ 2	13.48+ 2	9.00- 0
1023	ZNA	0000	30.0190	102.0149	-150.8	58	2812	14.1	4.8+ 0	7.9+ 5	0.5+ 0	1.66+ 2	15.41+ 2	9.30+ 0
1024	ZNA	0000	30.0189	102.0144	-146.8	39	2647	14.1	4.5+ 0	8.3+ 5	0.5- 0	1.83+ 3	17.34+ 3	9.49+ 0
1025	ZNA	0000	30.0189	102.0138	-146.4	56	2690	14.1	4.2+ 0	8.3+ 5	0.5+ 0	1.97+ 3	17.20+ 3	8.75- 0
1026	ZNA	0000	30.0189	102.0132	-144.9	57	2808	14.1	4.3+ 0	7.9+ 5	0.6+ 0	1.84+ 3	13.69+ 2	7.46- 0
1027	ZNA	0000	30.0189	102.0126	-144.9	44	2537	14.1	4.3+ 0	7.0+ 4	0.7+ 0	1.65+ 2	10.55+ 1	6.40- 0
1028	ZNA	0000	30.0188	102.0120	-143.1	54	2574	29.0	4.4+ 0	6.3+ 3	0.8+ 1	1.41+ 2	8.17+ 0	5.80- 0
1029	ZNA	0000	30.0188	102.0114	-142.2	57	2402	29.0	4.8+ 0	5.6+ 3	0.8+ 1	1.17+ 1	6.71+ 0	5.74- 0
1030	ZNA	0000	30.0188	102.0108	-141.9	56	2415	29.0	4.9+ 0	5.2+ 2	0.8+ 1	1.07+ 1	6.34+ 0	5.90- 0
1031	ZNA	0000	30.0188	102.0102	-139.9	50	2279	29.0	4.9+ 0	5.2+ 2	0.8+ 1	1.05+ 1	6.18+ 0	5.87- 0
1032	ZNA	0000	30.0188	102.0096	-139.2	54	2483	29.0	4.8+ 0	5.2+ 2	0.8+ 1	1.10+ 1	6.23+ 0	5.68- 0
1033	ZNA	0000	30.0187	102.0090	-139.5	54	2439	29.0	4.4+ 0	5.4+ 3	0.8+ 1	1.24+ 1	6.60+ 0	5.33- 1
1034	ZNA	0000	30.0187	102.0084	-138.5	53	2523	29.0	4.1+ 0	5.6+ 3	0.8+ 1	1.37+ 2	6.99+ 0	5.10- 1
1035	ZNA	0000	30.0187	102.0078	-138.0	50	2358	29.0	3.8+ 0	5.9+ 3	0.8+ 1	1.54+ 2	7.62+ 0	4.95- 1
1036	ZNA	0000	30.0187	102.0072	-136.0	53	2435	29.0	3.7- 0	6.0+ 3	0.7+ 0	1.65+ 2	8.28+ 0	5.03- 1
1037	ZNA	0000	30.0187	102.0067	-135.8	55	2304	29.6	3.8- 0	6.2+ 3	0.7+ 0	1.66+ 2	8.89+ 0	5.36- 1
1038	ZNA	0000	30.0186	102.0061	-134.5	35	2379	29.6	3.9+ 0	6.3+ 3	0.7+ 0	1.61+ 2	9.44+ 1	5.87- 0
1039	ZNA	0000	30.0186	102.0055	-134.5	41	2340	29.6	4.3+ 0	6.4+ 4	0.6+ 0	1.49+ 2	10.37+ 1	6.94- 0
1040	ZNA	0000	30.0186	102.0049	-132.5	40	2160	29.6	4.5+ 0	6.4+ 4	0.6+ 0	1.44+ 2	10.97+ 1	7.64- 0
1041	ZNA	0000	30.0186	102.0043	-136.8	39	2218	29.6	4.6+ 0	6.2+ 3	0.6+ 0	1.35+ 2	10.73+ 1	7.97- 0
1042	ZNA	0000	30.0186	102.0037	-131.1	52	2290	29.6	4.7+ 0	6.1+ 3	0.6+ 0	1.30+ 1	9.99+ 1	7.66- 0
1043	ZNA	0000	30.0185	102.0031	-130.8	38	2248	29.6	4.6+ 0	5.9+ 3	0.7+ 0	1.27+ 1	8.65+ 0	6.81- 0
1044	ZNA	0000	30.0185	102.0025	-130.8	42	2251	29.6	4.6+ 0	5.7+ 3	0.7+ 0	1.24+ 1	7.99+ 0	6.44- 0
1045	KBO	0000	30.0185	102.0019	-129.4	38	2149	29.6	4.5- 0	5.7+ 2	0.7+ 0	1.29+ 1	8.14+ 1	6.33- 0
1046	KBO	0000	30.0185	102.0013	-126.9	51	2384	29.4	4.3- 0	5.8+ 2	0.7+ 0	1.35+ 2	8.55+ 1	6.30- 0
1047	KBO	0000	30.0185	102.0007	-126.9	44	1990	29.4	4.3- 0	5.8+ 2	0.6- 0	1.35+ 2	9.24+ 1	6.85- 0
1048	KBO	0000	30.0184	102.0001	-123.1	38	2314	29.4	4.4- 0	5.7+ 2	0.6- 0	1.31+ 2	9.54+ 1	7.31- 0
1049	KBO	0000	30.0184	101.9995	-122.9	39	2233	29.4	4.5- 0	5.4+ 1	0.6- 0	1.19+ 1	9.32+ 1	7.82+ 0
1050	KBO	0000	30.0184	101.9989	-122.9	55	1988	29.4	4.6- 0	4.9+ 1	0.6- 0	1.06+ 1	8.68+ 1	8.19+ 0
1051	KBO	0000	30.0184	101.9984	-122.2	47	1955	29.4	4.7+ 0	4.6+ 1	0.6- 0	0.97+ 0	8.33+ 1	8.55+ 0
1052	KBO	0000	30.0184	101.9978	-119.7	52	1913	29.4	4.8+ 0	4.3+ 1	0.5- 0	0.90+ 0	8.29+ 1	9.19+ 0
1053	KBO	0000	30.0183	101.9972	-118.0	40	1770	29.4	4.6- 0	4.2+ 0	0.5- 0	0.91+ 0	8.76+ 1	9.63+ 0
1054	QAL	0000	30.0183	101.9966	-116.0	51	1725	29.4	4.5- 0	4.0+ 5	0.4- 1	0.90+ 2	9.72+ 4	10.79+ 2
1055	QAL	0000	30.0183	101.9960	-115.7	59	1641	32.4	4.1- 0	3.7+ 4	0.4- 1	0.90+ 2	9.59+ 4	10.63+ 2
1056	QAL	0000	30.0183	101.9954	-115.7	50	1566	32.4	3.7- 0	3.3+ 3	0.4- 1	0.91+ 2	8.45+ 3	9.31+ 1
1057	QAL	0000	30.0182	101.9948	-117.8	40	1376	32.4	3.5- 0	2.8+ 2	0.4- 1	0.81+ 2	6.49+ 2	7.99+ 0

CONTOUR INTERVAL= 0.50 SONORA ETH LAT 30.000 LONG-102.000



GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

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	11.00<L< 11.50	12.00<M< 12.50	13.00<N< 13.50	14.00<O< 14.50	15.00<P< 15.50
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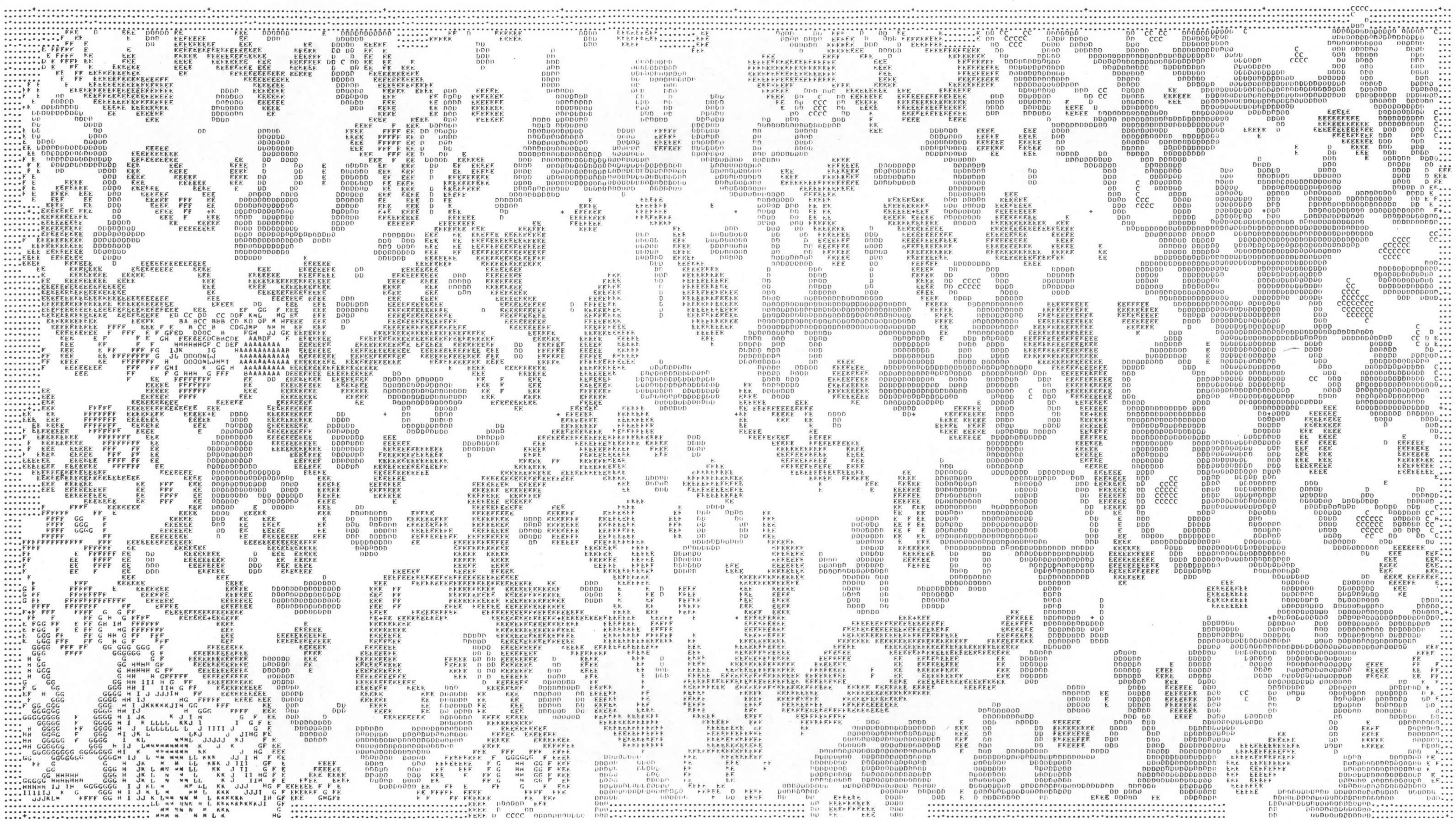
AIV-1 Line Printer Contour

CONTOUR INTERVAL= 0.20 SEGURA FD LAT 30.000 LONG=102.000



AIV-2 Line Printer Contour

GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

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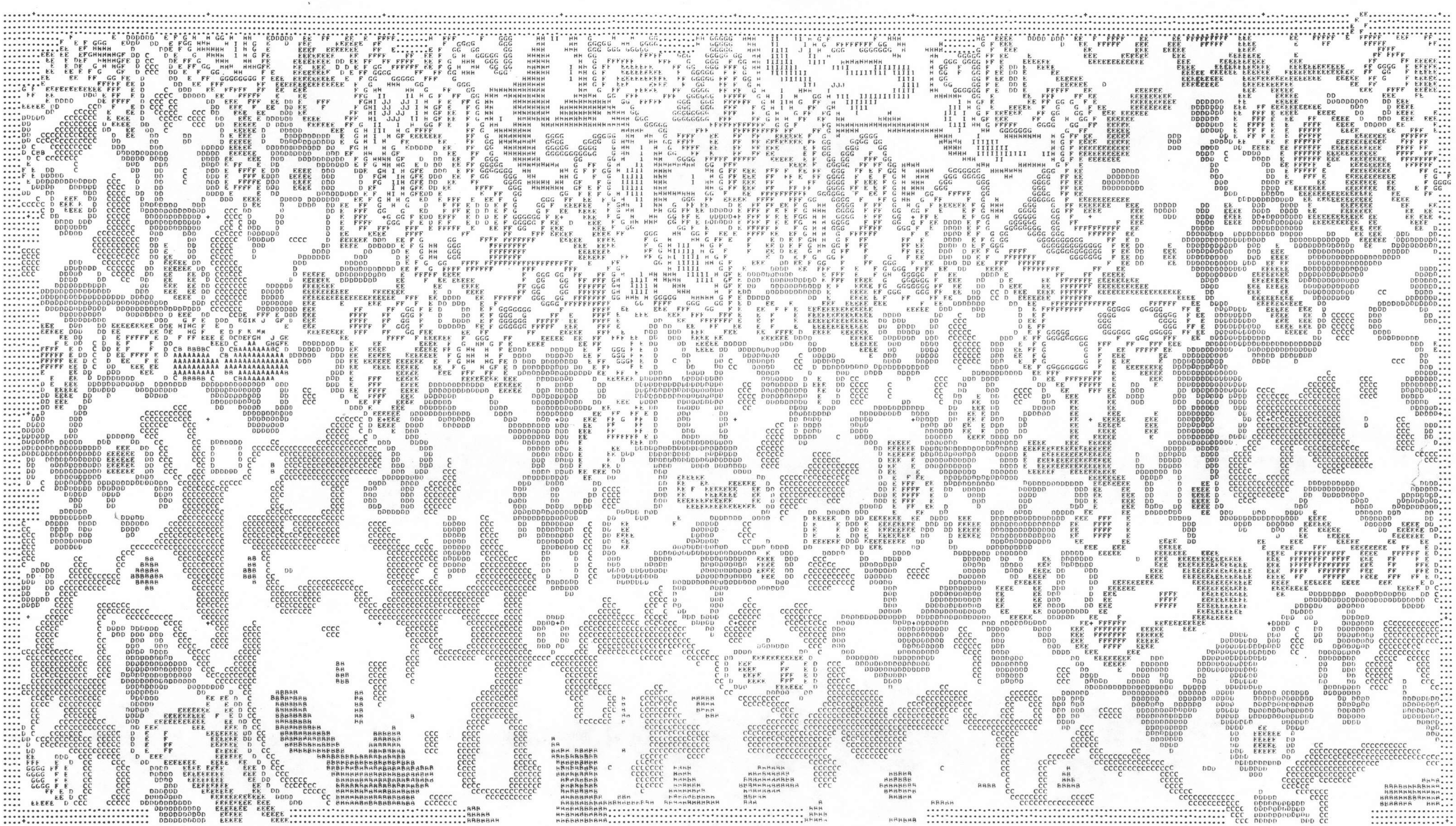
	4.40<L< 4.60	4.80<M< 5.00	5.20<N< 5.40	5.60<O< 5.80	6.00<P< 6.20
	6.40<Q< 6.60	6.80<R< 7.00	7.20<S< 7.40	7.60<T< 7.80	8.00<U< 8.20

CONTOUR INTERVAL= 0.08 SONORA %K LAT 30.000 LONG-102.000



GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

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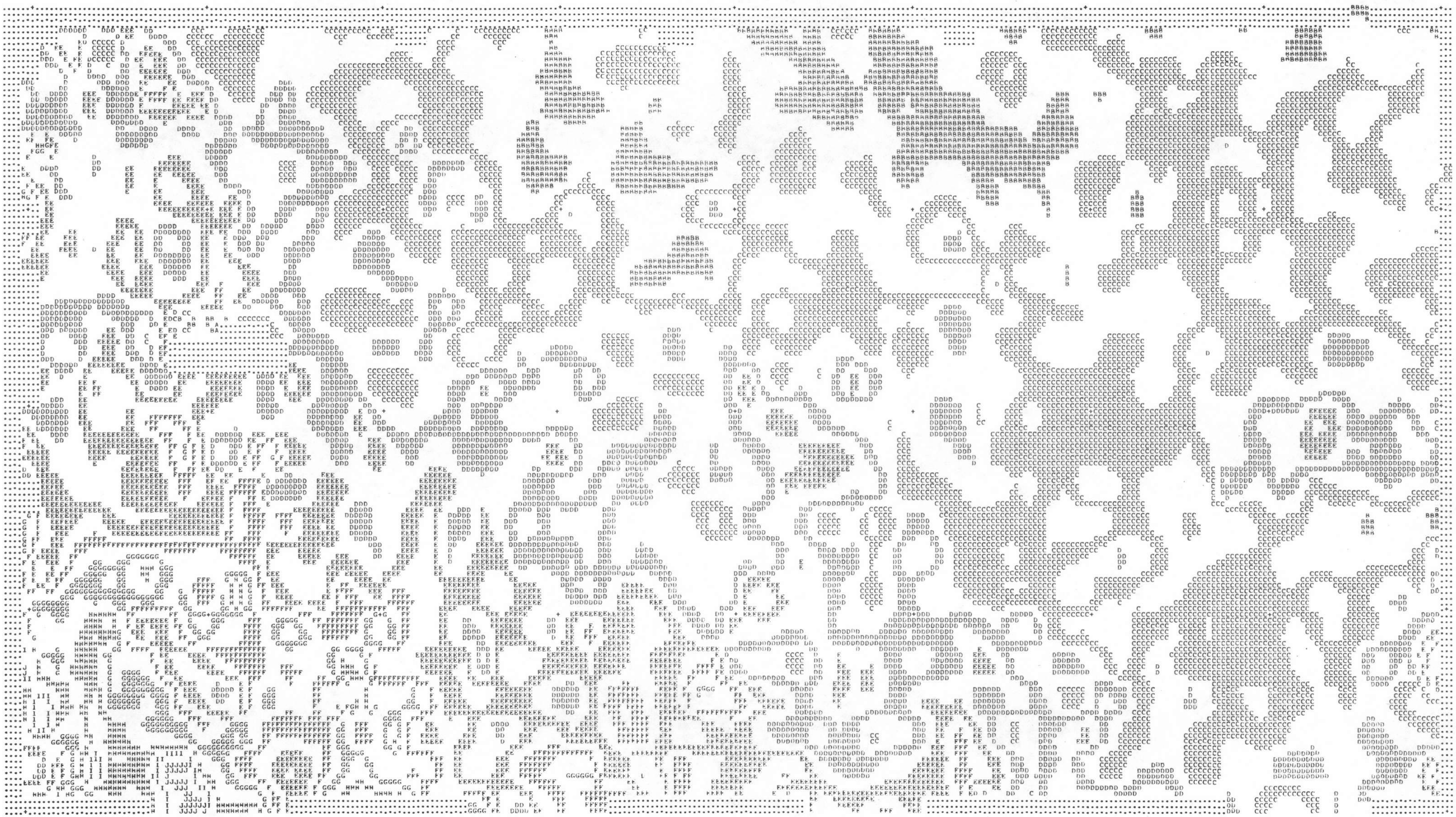
AIV-3 Line Printer Contour

CONTOUR INTERVAL= 0.07 SONORA EU/ETH LAT 30.000 LONG-102.000



GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

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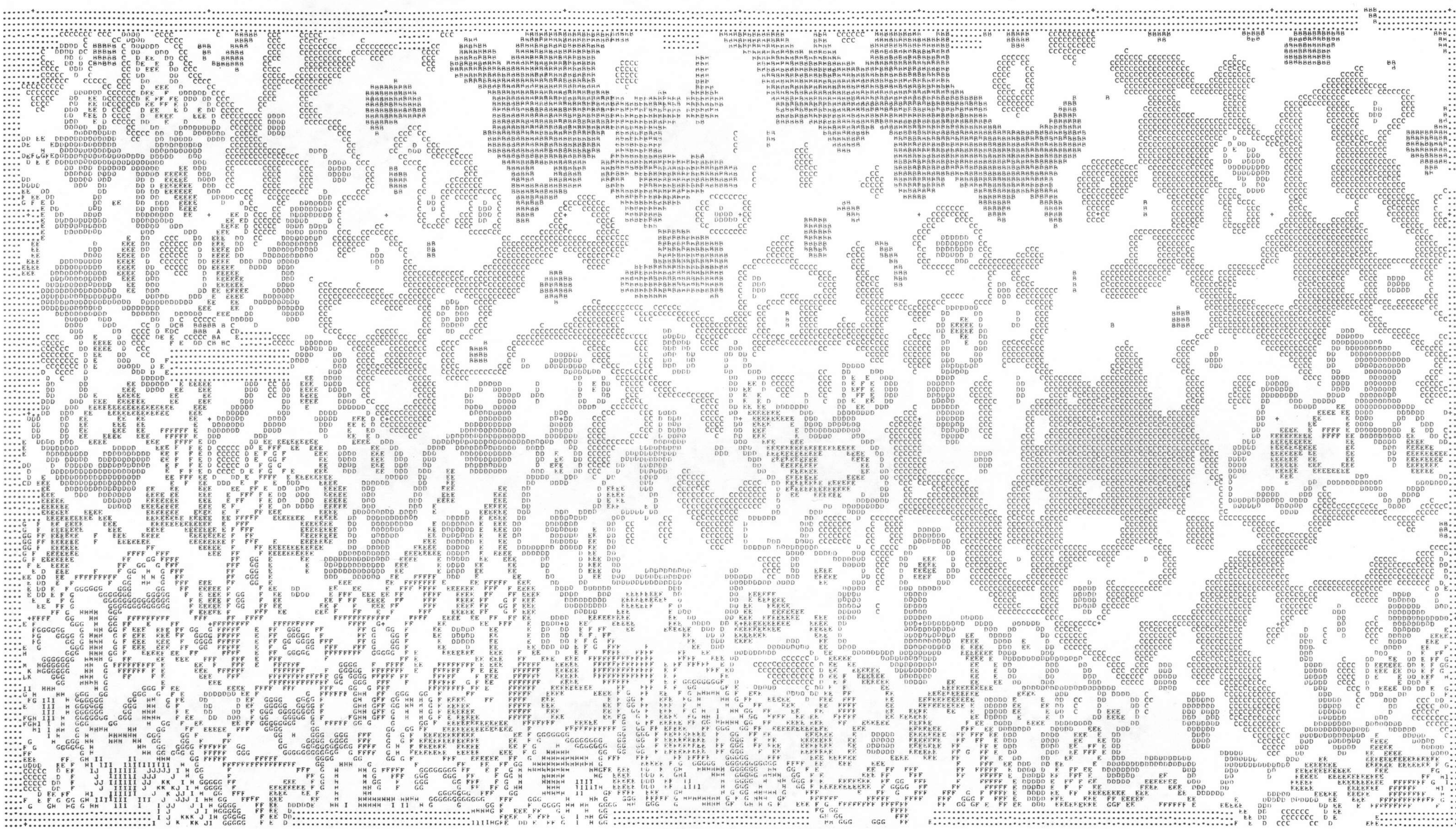
AIV-4 Line Printer Contour



GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

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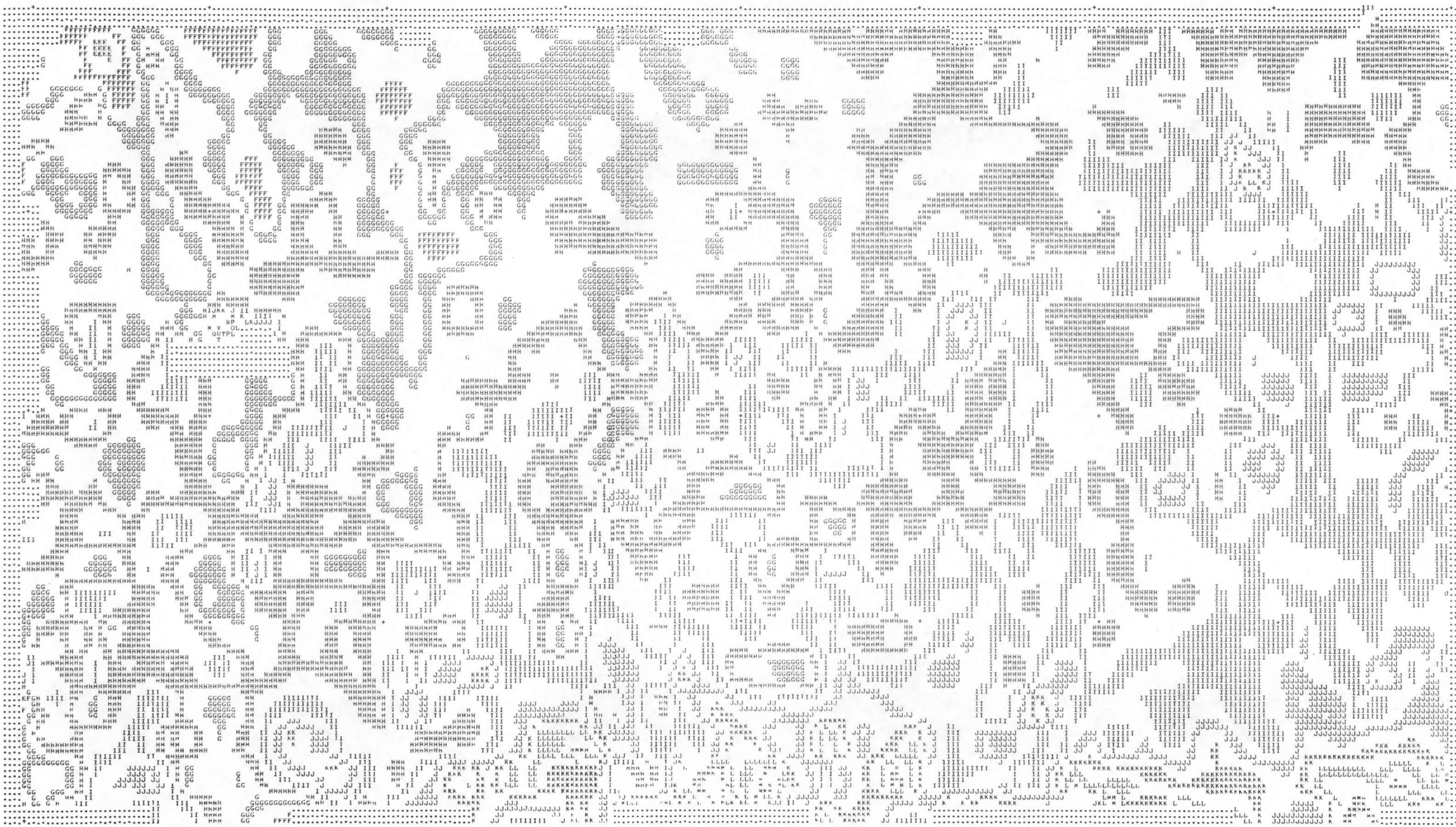
	6.00<G< 6.50	7.00<H< 7.50	8.00<I< 8.50	9.00<J< 9.50	10.00<K< 10.50
	11.00<L< 11.50	12.00<M< 12.50	13.00<N< 13.50	14.00<O< 14.50	15.00<P< 15.50
	16.00<Q< 16.50	17.00<R< 17.50	18.00<S< 18.50	19.00<T< 19.50	20.00<U< 20.50
	21.00<V< 21.50	22.00<W< 22.50	23.00<X< 23.50	24.00<Y< 24.50	25.00<Z< 25.50
	26.00<1< 26.50	27.00<2< 27.50	28.00<3< 28.50		

AIV-5 Line Printer Contour

CONTOUR INTERVAL= 0.50 SONORA EFH/K LAT 30.000 LONG=102.000



GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

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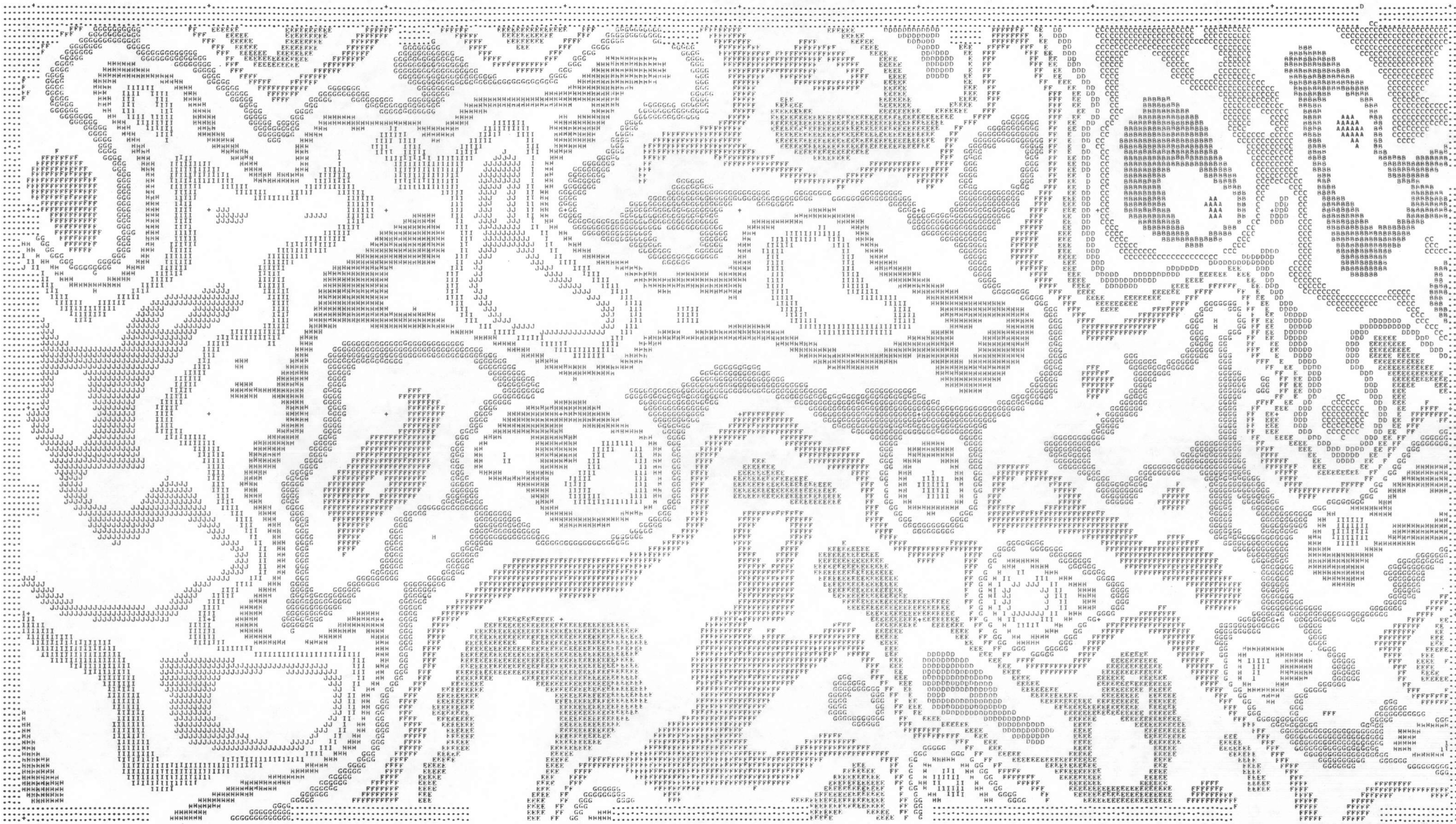
	6.00<G< 6.50	7.00<H< 7.50	8.00<I< 8.50	9.00<J< 9.50	10.00<K< 10.50
	11.00<L< 11.50	12.00<M< 12.50	13.00<N< 13.50	14.00<O< 14.50	15.00<P< 15.50
	16.00<Q< 16.50	17.00<R< 17.50	18.00<S< 18.50	19.00<T< 19.50	20.00<U< 20.50
	21.00<V< 21.50	22.00<W< 22.50	23.00<X< 23.50		

AIV-6 Line Printer Contour

CONTOUR INTERVAL= 50.00 SONORA R*AG LAT 30.000 LONG-102.000



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A< -750. -700.<B< -650. -600.<C< -550. -500.<D< -450. -400.<E< -350. -300.<F< -250.
-200.<G< -150. -100.<H< -50. 0.<I< 50. 100.<J< 150.

AIV-7 Line Printer Contour

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